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Thesis

# AN ANALYSIS AND EVALUATION OF ELEMENTARY ELECTRICITY TEXT BOOKS

Submitted by

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CONTENTS

## LIST OF TABLES

## STATEMENT OF PROBLEM

During the writer's twenty years as a teacher of electricity in public schools, the first question asked by almost every visiting teacher has been, "What textbook do you recommend for students beginning the study of electricity?" Regardless of the fact that the writer has read practically all elementary books published during the years he has been engaged as a teacher, he must admit that it is impossible for him to recommend any one of them to another teacher who would not rearrange, omit, and supplement the material with his own personal notes, job sheets and subject matter. Practically all visiting teachers have held the same opinion.

It is not difficult to discuss this problem with other members of the teaching profession, but when a doctor, lawyer, or layman, who has no one to guide him in the selection of material in a text, asks for a recommendation of a book that will give him a general idea of what electricity is all about, it is almost impossible to answer. After such a person has studied a book his impression will depend largely upon that author's interpretation of what is most important. Some authors emphasize history and early experiments; others, bells and wiring for lights; others stress formulas and problems; and another group places a picture of some electrical device or machine on every page and accompanies this with a lengthy description.

There are fundamentals that must be studied in any text, but it is impossible to tell from a study of the elementary electricity books available

what are fundamentals and what is supplementary material. The United States Department of the Interior hesitates to recommend a textbook because there are so many good science books that devote sections to electricity.[1] This is typical of what people think about electricity textbooks.

Therefore, in an effort to find a text that would meet the needs of a beginner in the subject, the writer determined to make this study.

## METHOD OF APPROACH

It occurred to the writer that an examination of the courses of study used in different schools might aid in the selection of a suitable elementary text, but it was discovered that this was impossible because there were as many courses of study as there were teachers. This was due to the method of appointing electricity teachers from the trade. Each teacher emphasized that phase of the work in which he had been engaged before his appointment.

In this connection no information could be secured from the following three states for reasons presented: the Wisconsin State Board of Vocational Education [2] and the Massachusetts Department of Education [3] have no uniform state courses; the State Education Department of the State of New York did not reply to the writer's inquiry.

The writer then turned his attention to what authors in the field of

1/ Personal letter from G.A.McGarvey, Agent, Industrial Education, Department of the Interior, U.S., dated April 8, 1938.

2/ Personal letter from H.C.Thayer, Teacher Training Supervisor for Wisconsin, dated April 4, 1938.

3/ Personal letter from A.R.Mack, Supervisor of Secondary Education for Massachusetts, dated April 6, 1938.

electricity had to say on the study and teaching of electricity. After having consulted card catalogues in every public and college library in Cambridge and Boston, Massachusetts, after having read all Industrial Arts and Vocational magazines for the past nine years, and after having consulted the following publications: Industrial Art Index, Educational Index, Periodicals Directory, Reader's Guide to Periodical Literature, Technical Book Review Index, Book Review Digest, Cumulative Book Index, and the United States Catalogue, he discovered only ten short articles.1/

The subject matter, viewpoints, and methods of these ten articles were so diversified that no tangible information could be secured from them.

1/ Collar, Tilden, "Course in Electricity for JuniorHigh School," Industrial Art and Vocational Education, XXV (February,1936), p.69-70.

Goppert, H.R., "Course in Electrical Work," Industrial Art and Vocational Education, XXIV (February,1935), p.17A-18A.

Terry, I.G., "Senior High School Electricity," Industrial Art and Vocational Education, XXII (March,1933; May,1933), p.141-143; p.193-195.

Rich, K.W., "How Shall We Teach Electricity?" Industrial Art and Vocational Education, XX (August,1931), p.273-275.

Jones, E.W., "Electricity in Secondary Schools," Industrial Art and Vocational Education, XX (October, 1931), p.355-357.

Selvidge, R.W., "Elementary Electricity for High Schools," Industrial Education Magazine, XXXIII (July,1931), p.17-18.

Yager, S.A., "Contract Plan Applied to Teaching of Elementary Electricity," Industrial Education Magazine, XXXIV (January,1933),p.128-129.

Golitz, F.I., "New Methods in Teaching Electricity," Industrial Education Magazine, XXXVI (November,1934), p.265.

Zeleny, A., "Teach Electricity from a Logical rather than a Historical Standpoint," Science, LXXVI (October, 1932), p.336-337.

McDougal, Wynne L., "A Short Tryout Course in Electricity," Industrial Education Magazine, XXXII (September,1930).

Then, too, the authors quoted neither authority nor evidence to substantiate their statements. No accounts were given of tests or follow-up work to prove the value of their conclusions or contentions. The writers agreed that fundamentals should be taught, but they differed widely as to what the fundamentals were and how they should be taught. Aims varied from "try-out" to preparation for industry. It was evident that nothing constructive is to be learned to aid in the solution of the problem until more has been written on the subject of the study and teaching of electricity.

The only course left open to the writer was to read the elementary textbooks. Research work to this point had made it clear that the consideration of a suitable text must include the topics to be discussed; proper sequence of topics; space to be devoted to each topic; and methods used to aid in presentation of the subject matter.

## ANALYSIS OF TEXTS

In order to limit the number of books and yet secure a wide variety, the writer contacted throughout the United States all publishers of high school electricity textbooks,[1/] requesting that they recommend all textbooks published by them that would be suitable for use as elementary texts for students in high school and for adults desirous of studying electricity. Out of a total of seventeen books recommended, the writer analyzed fifteen.[2/] The reason for excluding two was that their contents emphasized either house wiring [3/] or electricity for amusement.[4/]

1/ Standard Catalogue for High School Librarians with Supplement.

2/ See Appendix A, p.67.

3/ Poppe, T.W., House Wiring, 256 pp.

4/ Collins, A. Fredrick, Fun with Electricity.

To make certain that a homogeneous group had been obtained the writer analyzed the aims of each book, as stated in the preface. It was found that three aims were common to all: (1) to acquaint students with up-to-date theories, practices, and applications of electricity; (2) to present elementary fundamental principles and laws in clear and simple form; (3) to arouse interest and stimulate thinking. Other aims were expressed, but they were of a minor nature.

The writer then studied the chapter headings to see how the books compared in similarity of subject matter discussed. Out of a total of two hundred and eighty-four chapters it was evident on inspection that headings identically alike would be too few to be of any benefit. Even after chapters had been grouped together under one common heading, there remained ninety-eight which would have to be listed separately. It was also noticed that the heading of a chapter did not mean much because a topic discussed under one heading by one author would often be discussed under a different heading by another. For example, Lunt in his book 1/ discusses Ohm's law in chapter VII, the title of which is, "How Electric Current is Regulated." Meisner in his book 2/ discusses Ohm's law in chapter VIII, title of which is, "Electric Current or Flow of Electricity." In a text 3/ written by Small, Ohm's law is found in chapter VII, under the heading, "Measuring Electricity." Here was double evidence that subject matter was greatly diversified and that a finer analysis would have to be made.

1/ Lunt, Joseph R., Everyday Electricity, p.57.

2/ Meisner, Morris, Magnetism and Electricity, p.89.

3/ Small, Sidney A., Boys Book of Electricity, p.149.

## METHOD OF ANALYSIS CHOSEN

Guided by experience as a practical tradesman, as a teacher in day and evening schools, and as a student of electricity, the writer made a list of one hundred items which he believed should be discussed in an elementary electrical textbook and started to check each of the above-mentioned textbooks against this list for a preliminary check. After having studied two books it was evident that it would be necessary to add to the original list. In order to keep the list from becoming so large that it could not be handled easily and readily it was found necessary to consolidate items more or less related.[1/] While the writer was forced to add a few more items from time to time, he was able to keep the total number down to one hundred and thirteen.[2/]

Having ascertained that all subject matter in the fifteen books could be tabulated under one hundred and thirteen items, the writer proceeded to read each book once more, dividing it into different items and noting the relative position of each item. This was recorded in the left hand column [3/] of said items, under the heading: "Relative Position of Item."

In the right hand column opposite the item number, under the heading: "Number Pages each Item," there was placed the number of pages devoted to a discussion of topics in that item. Here again inconsistent methods used by authors made the item by item analysis difficult, since many of them make a

1/ See Table 1, p. 9-46.

2/ See Table 1, p. 9-46.

3/ See Table 1, p. 9-46.

practice of discussing a topic piecemeal throughout the text. For example, Black in his book 1/ on page 144 mentions the word "alternator." On pages 350-366 he discusses alternators and on page 417 he devotes one-half of a page to a further discussion of alternators. In cases of this kind, and there were many of them, the relative position of such an item was determined by the location of the main discussion, rather than its first appearance in the book.

The total number of pages credited to any item was determined by the sum of all pages devoted to a discussion of that item.

An inspection of data 2/ showed that the arrangement of items varied widely, as did the number of pages devoted to each item.

The next step was to find the median of the position of each item in order to determine what position it occupied in the opinions of all fifteen authors. This reduced the number of items to sixty-four.3/ (Unless eight or more of the fifteen authors discussed an item, its median could not be found.)

The mean was used to determine how many pages would be devoted to an item, providing each author had written the same number of pages. In finding the number of pages to an item, an exact measure was not used, but a rough estimate was employed. If an author had given less than one-half of a page, but more than one-quarter to a topic, then for statistical purposes it was considered as one-quarter page. In other words, in fractional pages

1/ Black, N.Henry, Elementary Electricity and Magnetism.

2/ See Table 1, p.9-46.

3/ See Table 2, p.47-49.

the estimate of space was one-quarter, one-half, or three-quarters. When recording pages as calculated by use of a mean, the same scheme was followed. If the mean was 3.8 it was recorded as 3.75.

The order in which these items appeared, based on the median of each item and space devoted to each as shown by the approximate mean, appears in Table 2.

The following table, Table 1, "Analysis of Content of Electric Textbooks," is read as follows:

Opposite Book A, under heading "Permanent Magnets and Magnets," and sub-heading "Relative Position of Item," appears the number 1. This number indicates that the topic discussed first by the author of Book A was "Permanent Magnets and Magnets." Under sub-heading "Number of Pages Each Item," is found the number 11. This number means that there were eleven pages devoted to this topic. If a dash (-) is used in place of a number, as occurs under the heading, "Introduction to Electricity," it indicates that the topic was not discussed.

A study of the heading, "Primary Cells" and its sub-headings shows that in Book A this topic ranked seventh in order of discussion and that there were thirteen pages devoted to it.

Table 1. Analysis of Content of Electric Textbooks

| Book | Permanent Magnets and Magnets | | Introduction to Electricity | | Magnetism | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 1 | 11 | - | - | 2 | 9 |
| B | 25 | 5 | - | - | 24 | 3.5 |
| C | 40 | 6 | 1 | 6 | 21 | 11.5 |
| D | 3 | 4 | 3 | 26.5 | 2 | 27 |
| E | 1 | 7 | - | - | 2 | 7 |
| F | 1 | 2 | - | - | 2 | 13 |
| G | 27 | 0.25 | 1 | 1 | - | - |
| H | 18 | 3 | 1 | 4 | 19 | 1 |
| I | 1 | 8 | - | - | 2 | 4 |
| J | 5 | 9 | 1 | 14 | 6 | 4.5 |
| K | 33 | 2 | 1 | 17.5 | 36 | 11 |
| L | 9 | 2 | 1 | 1.5 | 8 | 3.5 |
| M | 8 | - | - | - | 9 | 7 |
| N | 18 | 2 | 1 | 7 | 20 | 3.5 |
| O | 2 | 7.5 | - | - | 3 | 2 |
| Approximate Average Pages | | 4.5 | | 5.25 | | 7 |
| Range of Pages | | 0 - 11 | | 0 - 26.5 | | 0 - 13 |
| Number of Books Included Item | 15 | | 8 | | 14 | |
| Median Relative Positions | 6.75 | | 3 | | 11.5 | |
| Relative Position of Item, Based on Median | II | | I | | VIII | |

Table 1. (Continued)

| Book | Voltaic Cell Simple Electric Cell Electro Chemistry | | Primary Cells | | Ampere Current Measure Current | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 3 | 14 | 7 | 13 | 4 | 6.5 |
| B | 10 | - | 39 | 3.5 | 1 | 1 |
| C | 2 | 2.5 | 3 | 18.5 | 4 | 1.5 |
| D | 33 | 2 | 35 | 28 | 9 | 1 |
| E | 7 | 7 | 9 | 3.5 | 18 | 2 |
| F | 21 | 3 | 24 | 9.5 | 10 | 0.5 |
| G | 19 | 2 | 20 | 4 | 2 | 1 |
| H | 32 | 3 | 33 | 1.5 | 5 | 1 |
| I | - | - | 9 | 3 | 3 | 2 |
| J | 7 | 6 | 8 | 6.5 | 16 | 4 |
| K | 9 | 15 | 10 | 5 | 14 | 6.5 |
| L | 4 | 2.5 | 5 | 6 | 22 | 2 |
| M | 1 | 5.5 | 5 | 2 | 15 | 0.5 |
| N | 13 | 1.5 | 15 | 2 | 4 | 2.5 |
| O | 8 | 2.5 | 9 | 2.5 | 13 | 0.5 |
| Approximate Average Pages | | 4.5 | | 7.25 | | 2.25 |
| Range of Pages | | 0 - 15 | | 1.5 - 28 | | .5 - 6.5 |
| Number of Books Included Item | 14 | | 15 | | 15 | |
| Median Relative Positions | 11.5 | | 7 | | 9.25 | |
| Relative Position of Item, Based on Median | XIV | | III | | VII | |

Table 1. (Continued)

| Book | Volts | | E.M.F. Potential | | Efficiency | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 14 | 2 | 6 | 1.5 | 23 | 1 |
| B | 3 | 0.5 | 5 | 1.5 | 16 | 2.5 |
| C | 6 | 0.25 | 7 | 0.75 | 17 | 0.5 |
| D | 7 | 1 | 6 | 4 | 20 | 2 |
| E | 16 | 0.75 | - | - | - | - |
| F | 13 | 0.25 | 14 | 1.25 | 50 | 3 |
| G | 4 | 3 | 18 | 6 | 13 | 1 |
| H | 6 | 0.5 | 2 | 0.25 | 44 | 0.5 |
| I | 5 | 0.5 | 34 | 0.5 | - | - |
| J | 17 | 1 | - | - | - | - |
| K | 15 | 0.25 | 11 | 1.5 | - | - |
| L | 7 | - | - | - | - | - |
| M | 17 | 1 | 3 | 1 | 35 | 0.25 |
| N | 5 | 1.75 | - | - | - | - |
| O | 15 | 1.5 | - | - | - | - |
| Approximate Average Pages | | 1 | | 1 | | 0.75 |
| Range of Pages | | 0 - 3 | | 0 - 6 | | 0 - 3 |
| Number of Books Included Item | 15 | | 10 | | 8 | |
| Median Relative Positions | 8.75 | | 14.5 | | 50.5 | |
| Relative Position of Item, Based on Median | VI | | IX | | XLV | |

Table 1. (Continued)

| Book | Conductance Resistance | | Ohm Ohm's Law | | Circular Mil Resistance of Wire Wires | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 8 | 2 | 15 | 3 | 9 | 14 |
| B | 4 | 0.5 | 7 | 3 | 19 | 5 |
| C | 5 | 2.5 | 9 | 3 | 11 | 4.5 |
| D | 10 | 4 | 13 | 3.5 | 15 | 10 |
| E | 14 | 1 | 19 | - | - | - |
| F | 6 | 8 | 15 | 1.25 | 8 | 7 |
| G | 5 | 1 | 6 | 2 | 15 | 9 |
| H | 7 | 1.5 | 8 | 1.5 | 27 | 4 |
| I | 7 | 1 | 15 | 8.5 | - | - |
| J | 21 | 5 | 18 | - | 15 | 2.5 |
| K | 30 | 5 | 21 | 9.5 | 28 | 0.5 |
| L | 20 | - | 19 | 2 | 47 | 1 |
| M | 16 | 1 | 18 | 3 | 30 | 2 |
| N | 6 | 1.5 | 22 | 8 | 27 | 4 |
| O | 16 | 5.5 | 20 | 6.5 | 45 | 0.75 |
| Approximate Average Pages | | 2.5 | | 3.75 | | 4.25 |
| Range of Pages | | 0 - 8 | | 0 - 9.5 | | 0 - 14 |
| Number of Books Included Item | 15 | | 15 | | 13 | |
| Median Relative Positions | 7 | | 15.10 | | 25.17 | |
| Relative Position of Item, Based on Median | IV | | XI | | XXII | |

Table 1. (Continued)

| Book | Measure Resistance with Voltmeter and Ammeter | | Measure Resistance - All Other Methods | | Fuses | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 37 | 1 | 38 | 25 | 41 | 2 |
| B | 10 | 0.5 | 22 | 21 | 17 | - |
| C | 41 | 1 | 42 | 9 | 20 | 1 |
| D | - | - | - | - | - | - |
| E | - | - | - | - | 32 | 1.5 |
| F | 30 | 2 | 31 | 11 | 88 | 2 |
| G | 7 | 0.5 | - | - | - | - |
| H | 13 | 1 | 26 | 3 | 15 | 1 |
| I | - | - | - | - | Photo Only | |
| J | - | - | - | - | 24 | 5 |
| K | - | - | 31 | 1.5 | 2 | - |
| L | 39 | 1 | - | - | 35 | 0.25 |
| M | 27 | 2 | 29 | 4.5 | 44 | 0.75 |
| N | 23 | 0.25 | - | - | 31 | 2 |
| O | 19 | 1 | - | - | 37 | 3 |
| Approximate Average Pages | | 0.75 | | 5 | | 1.25 |
| Range of Pages | | 0 - 2 | | 0 - 25 | | 0 - 5 |
| Number of Books Included Item | 10 | | 7 | | 12 | |
| Median Relative Positions | 38.5 | | - | | 36.75 | |
| Relative Position of Item, Based on Median | XXXV | | - | | XXXIII | |

Table 1. (Continued)

| Book | Parallel Circuits | | Series Circuits | | Parallel Series | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 17 | 3 | 17 | 1 | 19 | 1 |
| B | 12 | 5 | 11 | 2.5 | - | - |
| C | 13 | 3.5 | 12 | 2 | 14 | 1.5 |
| D | 22 | 5.5 | 21 | 2 | 23 | 0.25 |
| E | 21 | 0.25 | 22 | 0.25 | - | - |
| F | 17 | 3.5 | 7 | 0.75 | 18 | 1.5 |
| G | 9 | 11 | 8 | 10 | - | - |
| H | 30 | 2.25 | 11 | 5 | 31 | 1 |
| I | 18 | 2 | 27 | 6.5 | - | - |
| J | - | - | - | - | - | - |
| K | 19 | 0.5 | 18 | 1 | 20 | 3.5 |
| L | - | - | - | - | - | - |
| M | 20 | 6 | 19 | 3.5 | 22 | 3 |
| N | 30 | 5 | 29 | 3 | - | - |
| O | 47 | 2.25 | 46 | 1 | - | - |
| Approximate Average Pages | | 3.25 | | 2.5 | | 0.75 |
| Range of Pages | | 0 - 11 | | 0 - 10 | | 0 - 3.5 |
| Number of Books Included Item | 13 | | 13 | | 7 | |
| Median Relative Positions | 21.5 | | 19.83 | | - | |
| Relative Position of Item, Based on Median | XVII | | XIV | | - | |

Table 1. (Continued)

| Book | Battery Connections Ohm's Law for Batteries | | Heating Effect of a Current | | Chemical Effects of a Current Electroplating | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 20 | 16 | 10 | 1 | 11 | 6 |
| B | - | - | 15 | 3 | 41 | 5 |
| C | - | - | 18 | 1.5 | 51 | 19.5 |
| D | 36 | 6.5 | 19 | 0.5 | 37 | 3 |
| E | - | - | 28 | 5 | - | - |
| F | 23 | 8 | - | - | 26 | 1 |
| G | 21 | 15 | 22 | 4 | 23 | 3.5 |
| H | 36 | 1.5 | 14 | 1.5 | 16 | 3 |
| I | 16 | 6 | 13 | 0.5 | - | - |
| J | 9 | - | 22 | 1 | 44 | 7.5 |
| K | 3 | 2.5 | 23 | 2 | - | - |
| L | 6 | 2.5 | - | - | 44 | 0.5 |
| M | 21 | 4 | 43 | 2 | 6 | 4 |
| N | 17 | 2 | 12 | 0.25 | 10 | 0.25 |
| O | 11 | 2 | 43 | 4.5 | - | - |
| Approximate Average Pages | | 4.5 | | 2 | | 3.5 |
| Range of Pages | | 0 - 16 | | 0 - 5 | | 0 - 19.5 |
| Number of Books Included Item | 12 | | 13 | | 11 | |
| Median Relative Positions | 21.17 | | 21.17 | | 41.17 | |
| Relative Position of Item, Based on Median | XV | | XVI | | XI | |

Table 1. (Continued)

| Book | Paralleling Generators | | Polarity Tester Test A.C.-D.C. | | Electromagnetic Electromagnetism Magnetic Effect of Current | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 60 | 2 | 12 | 0.5 | 26 | 10 |
| B | 33 | 2.5 | - | - | 26 | 3 |
| C | 47 | 3.5 | - | - | 22 | 5.5 |
| D | - | - | 25 | 0.5 | 26 | 11 |
| E | - | - | - | - | 3 | 2 |
| F | 51 | 2.5 | - | - | 3 | 8 |
| G | - | - | - | - | 25 | 2 |
| H | 39 | 5 | - | - | 20 | 1 |
| I | - | - | - | - | 29 | 3 |
| J | - | - | - | - | 10 | 7 |
| K | - | - | 26 | 1.5 | 37 | 0.5 |
| L | - | - | 23 | 3 | 10 | 1 |
| M | - | - | - | - | 10 | 3 |
| N | - | - | - | - | 26 | 1 |
| O | - | - | - | - | 4 | 2 |
| Approximate Average Pages | | 1.2 | | 0.5 | | 4 |
| Range of Pages | | 0 - 3.5 | | 0 - 3. | | 0 - 11 |
| Number of Books Included Item | 5 | | 4 | | 15 | |
| Median Relative Positions | - | | - | | 21.5 | |
| Relative Position of Item, Based on Median | - | | - | | XVIII | |

Table 1. (Continued)

| Book | Magnetic Circuits and Windings | | Solenoid Electro Magnet | | Electro Magnetic Induction Lenz's Law | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 29 | 1 | 27 | 21 | 51 | 10 |
| B | 29 | 8 | 28 | 4 | 31 | 5 |
| C | 26 | 8.5 | 23 | 2 | 29 | 8 |
| D | 27 | 42.5 | 28 | 12.5 | 39 | 23.5 |
| E | - | - | 4 | 6 | 11 | 7 |
| F | 34 | 9 | 5 | 4 | 36 | 2 |
| G | - | - | 26 | 3 | 39 | 1 |
| H | - | - | 21 | 1.25 | 35 | 1 |
| I | 39 | 1 | 30 | 2.5 | 31 | 5.25 |
| J | - | - | 12 | 6 | 35 | 2.5 |
| K | 34 | 5 | 35 | 0.5 | 39 | 4 |
| L | - | - | 12 | 2 | - | - |
| M | 14 | 1 | 11 | 2 | 31 | 3 |
| N | - | - | 19 | 2 | 41 | 3.5 |
| O | - | - | 5 | 3 | 23 | 3.5 |
| Approximate Average Pages | | 6.5 | | 4.75 | | 5.25 |
| Range of Pages | | 0 - 42.5 | | 0.5 - 21 | | 0 - 23.5 |
| Number of Books Included Item | 8 | | 15 | | 14 | |
| Median Relative Position | 40 | | 21.5 | | 34.5 | |
| Relative Position of Item, Based on Median | XXXVII | | XIX | | XXVIII | |

Table 1. (Continued)

| Book | Dynamo D.C. Machinery | | Generator D.C. Generator | | Electro Dynamics Introduction to Motors | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 57 | 1 | 58 | 34 | 30 | 11 |
| B | - | - | 32 | 28 | 35 | 3 |
| C | 43 | 1 | 44 | 24.5 | 48 | 3 |
| D | 48 | 0.25 | 49 | 43 | 51 | 18 |
| E | 12 | 8.5 | - | - | 26 | 5 |
| F | 44 | 7.5 | 45 | 33 | 46 | 13 |
| G | 37 | 3 | 38 | 12 | 40 | 4 |
| H | - | - | 37 | 25 | 41 | 7 |
| I | 10 | 9 | 12 | 3.5 | 33 | 3 |
| J | 30 | 8 | 32 | - | 34 | 1 |
| K | 42 | 1.5 | 41 | 3 | 44 | 4.5 |
| L | 26 | 11 | - | - | 27 | 2 |
| M | - | - | 34 | 10.5 | 37 | 3 |
| N | 33 | 1 | 34 | 4 | 35 | 0.25 |
| O | 26 | - | 28 | 3.75 | 38 | 10 |
| Approximate Average Pages | | 3.5 | | 14.5 | | 5.75 |
| Range of Pages | | 0 - 11 | | 0 - 43 | | 0.25 - 18 |
| Number of Books Included Item | 12 | | 13 | | 15 | |
| Median Relative Position | 41.17 | | 39.25 | | 36.25 | |
| Relative Position of Item, Based on Median | XXXIX | | XXXVI | | XXXII | |

Table 1. (Continued)

| Book | D.C. Motors, Starters, and Switches | | Armature Winding and Armature Reactance | | Potentiometer | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 61 | 27 | 59 | 25 | 34 | 2.5 |
| B | 36 | 36 | 34 | 4.25 | - | - |
| C | 49 | 22.5 | 45 | 3 | - | - |
| D | 52 | 20.5 | 50 | 26 | - | - |
| E | 27 | 2.5 | - | - | - | - |
| F | 47 | 15 | 43 | 13 | 30 | 7.5 |
| G | 41 | 17 | - | - | - | - |
| H | 42 | 22.5 | 40 | 6 | - | - |
| I | - | - | - | - | - | - |
| J | - | - | - | - | - | - |
| K | 45 | 6 | - | - | - | - |
| L | 28 | 2 | - | - | - | - |
| M | 38 | 18.5 | 40 | 2.5 | - | - |
| N | 36 | 4 | - | - | - | - |
| O | 39 | - | - | - | - | - |
| Approximate Average Pages | | 13.5 | | 5.25 | | 0.75 |
| Range of Pages | | 0 - 36 | | 0 - 26 | | 0 - 7.5 |
| Number of Books Included Item | 13 | | 7 | | 2 | |
| Median Relative Position | 43.5 | | - | | - | |
| Relative Position of Item, Based on Median | XLI | | - | | - | |

Table 1. (Continued)

| Book | Ammeters Milli-Ammeters | | Voltmeter Milli-Voltmeter | | Watt Meter | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 32 | 18 | 33 | 4.5 | 35 | 2 |
| B | 8 | 0.75 | 9 | 1 | 14 | 0.5 |
| C | 35 | 8 | 36 | 2 | 37 | 2 |
| D | 5 | - | - | - | - | - |
| E | 20 | - | 17 | - | - | - |
| F | 28 | 6 | 29 | 6 | 64 | 5 |
| G | 43 | 7.5 | 45 | 4 | 46 | 0.5 |
| H | 9 | 1.5 | 10 | 1 | 56 | 1 |
| I | 4 | 3 | 6 | 3.5 | - | - |
| J | - | - | - | - | - | - |
| K | - | - | 22 | - | - | - |
| L | 36 | 4 | 38 | 1 | 40 | 1 |
| M | 24 | 5 | 25 | 4.25 | 26 | 2 |
| N | 8 | 0.5 | 9 | 1.5 | - | - |
| O | 17 | 1 | 18 | 1 | - | - |
| Approximate Average Pages | | 3.75 | | 2 | | 1 |
| Range of Pages | | 0 - 18 | | 0 - 6 | | 0 - 2 |
| Number of Books Included Item | 13 | | 13 | | 8 | |
| Median Relative Position | 22.5 | | 26.5 | | 62.5 | |
| Relative Position of Item, Based on Median | XX | | XXV | | LII | |

Table 1. (Continued)

| Book | Galuanometer | | Watt Hour Meter Calculate Cost from Readings | | Storage Battery | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 31 | 18 | 36 | 7 | 25 | 23 |
| B | - | - | - | - | 42 | 11 |
| C | 34 | 5.5 | 38 | 2 | 52 | 13 |
| D | - | - | - | - | 38 | 13.5 |
| E | - | - | - | - | 10 | 8 |
| F | 27 | 6 | 33 | 8 | 25 | 16 |
| G | - | - | 47 | 2 | 24 | 6 |
| H | - | - | 45 | 3.5 | 34 | 3.5 |
| I | - | - | - | - | 40 | 42.5 |
| J | 11 | 0.25 | 20 | - | 49 | 2.5 |
| K | 38 | 0.5 | 53 | 2.5 | 12 | 6 |
| L | 11 | - | 41 | 2.5 | 43 | 2 |
| M | 23 | 0.75 | 42 | 4 | 7 | 3.5 |
| N | 7 | 0.5 | 25 | 1 | 16 | 4.5 |
| O | 24 | - | 22 | 4 | 12 | 7.25 |
| Approximate Average Pages | | 2 | | 2.5 | | 12 |
| Range of Pages | | 0 - 18 | | 0 - 8 | | 2.5 - 42.5 |
| Number of Books Included Item | 9 | | 11 | | 15 | |
| Median Relative Position | 34.5 | | 43 | | 26 | |
| Relative Position of Item, Based on Median | XXIX | | XL | | XXIV | |

Table 1. (Continued)

| Book | Heat Effect of Current Capacity of Wires - Tables | | Kirchoff's Law | | Conductors Insulators | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 39 | 2 | 43 | 11.5 | 5 | 1 |
| B | 21 | 3 | 15 | 2 | 49 | 0.75 |
| C | 19 | 5.5 | 24 | 1 | 8 | 4 |
| D | 16 | 2.5 | - | - | 12 | 1.5 |
| E | 31 | 4 | 22 | 9 | 15 | 1 |
| F | 16 | 1 | - | - | 11 | 1 |
| G | 16 | 3 | - | - | 14 | 0.75 |
| H | 29 | 2 | - | - | 25 | 0.75 |
| I | - | - | - | - | 8 | 6 |
| J | - | - | - | - | 3 | 2 |
| K | - | - | - | - | 27 | 1 |
| L | 46 | 1 | - | - | - | - |
| M | 46 | 1 | - | - | - | - |
| N | 28 | 1 | - | - | 26 | 2 |
| O | 44 | 1 | - | - | 7 | 1 |
| Approximate Average Pages | | 1.75 | | 1.5 | | 1.5 |
| Range of Pages | | 0 - 5.5 | | 0 - 11.5 | | 0 - 4 |
| Number of Books Included Item | 12 | | 4 | | 12 | |
| Median Relative Position | 32 | | - | | 15.5 | |
| Relative Position of Item, Based on Median | XXVII | | - | | XII | |

Table 1. (Continued)

| Book | Resistance vs Temperature | | Electric Welding | | Heating Devices | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 40 | 2 | 42 | 2.5 | 43 | 3 |
| B | 20 | 3.5 | - | - | 18 | 0.5 |
| C | 10 | 1.25 | 86 | 5 | 85 | 7.5 |
| D | 17 | 3 | - | - | - | - |
| E | - | - | - | - | 30 | 0.5 |
| F | 9 | 2 | - | - | - | - |
| G | - | - | - | - | - | - |
| H | - | - | - | - | - | - |
| I | - | - | - | - | 14 | 1 |
| J | - | - | - | - | 23 | 1.5 |
| K | 32 | 0.5 | - | - | 55 | 1.5 |
| L | - | - | - | - | 35 | 1.25 |
| M | 28 | 1 | - | - | - | - |
| N | - | - | - | - | 45 | 3.5 |
| O | - | - | - | - | 48 | 12 |
| Approximate Average Pages | | 1 | | 3.75 | | 2.25 |
| Range of Pages | | 0 - 3.5 | | 2.5 - 5 | | 0 - 7.5 |
| Number of Books Included Item | 7 | | 2 | | 10 | |
| Median Relative Position | - | | - | | 47.5 | |
| Relative Position of Item, Based on Median | - | | - | | XLII | |

Table 1. (Continued)

| Book | Thermo-Couple Thermo-Pile Pyrometer | | Three Wire System One Phase of D.C. | | Interior Wiring House Wiring Wiring Devices | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 44 | 3 | 50 | 1 | 63 | 2 |
| B | 23 | 0.75 | 44 | 3.5 | - | - |
| C | 87 | 3 | 77 | 2 | 79 | 6 |
| D | 34 | 6.5 | 70 | 9.5 | - | - |
| E | - | - | - | - | - | - |
| F | - | - | 78 | 4 | 88 | 24.5 |
| G | 30 | 1 | 17 | 6 | 10 | 11.5 |
| H | - | - | 66 | 6 | - | - |
| I | - | - | 22 | 7.5 | - | - |
| J | - | - | - | - | 25 | 2.5 |
| K | - | - | 25 | 4 | 51 | 4 |
| L | - | - | - | - | 34 | 13.5 |
| M | - | - | 71 | 1.5 | 72 | 0.5 |
| N | 14 | - | - | - | 47 | 7 |
| O | - | - | 34 | 2.5 | 35 | 14.5 |
| Approximate Average Pages | | 9.75 | | 3.25 | | 5.75 |
| Range of Pages | | 0 - 6.5 | | 0 - 9.5 | | 0 - 24.5 |
| Number of Books Included Item | 6 | | 11 | | 10 | |
| Median Relative Position | - | | 68 | | 73 | |
| Relative Position of Item, Based on Median | - | | LV | | LVIII | |

Table 1. (Continued)

| Book | Bells, Signalling Devices Bell Wiring | | Calibrate Instruments | | Coloumb | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | - | - | - | - | 13 | 2 |
| B | - | - | - | - | 2 | - |
| C | 24 | 3.5 | 39 | 4 | 40 | - |
| D | 29 | 0.25 | - | - | 11 | - |
| E | 6 | 1.75 | - | - | - | - |
| F | 86 | 5 | - | - | 12 | 0.25 |
| G | 28 | 15 | 44 | 0.5 | 3 | 0.25 |
| H | 22 | 0.5 | - | - | 4 | - |
| I | 28 | 13 | - | - | - | - |
| J | 14 | 5 | - | - | - | - |
| K | 52 | 6 | - | - | 13 | - |
| L | 13 | 7 | 37 | 0.5 | - | - |
| M | 13 | 0.5 | - | - | 15 | 0.5 |
| N | 48 | 1 | - | - | - | - |
| O | 6 | 10 | - | - | 14 | 0.25 |
| Approximate Average Pages | | 3.75 | | 0.25 | | 0.25 |
| Range of Pages | | 0 - 15 | | 0 - 4 | | 0 - 2 |
| Number of Books Included Item | 13 | | 3 | | 10 | |
| Median Relative Position | 25.5 | | - | | 15 | |
| Relative Position of Item, Based on Median | XXIII | | - | | X | |

Table 1. (Continued)

| Book | Volts Drop Line Drop Measure Volts | | Other Measuring Instruments | | Prony Brake | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 21 | 14 | 14 | 6 | 62 | 1 |
| B | 6 | 1 | - | - | 36 | 1 |
| C | 83 | 0.25 | - | - | 50 | 1.5 |
| D | 8 | 2 | - | - | 53 | 1.5 |
| E | - | - | - | - | - | - |
| F | 20 | 2 | 66 | 6 | 48 | 3.5 |
| G | 11 | 4 | - | - | - | - |
| H | 12 | 3.25 | - | - | - | - |
| I | 19 | 0.5 | - | - | - | - |
| J | - | - | - | - | - | - |
| K | 24 | 0.75 | - | - | - | - |
| L | - | - | - | - | - | - |
| M | 47 | 0.5 | 69 | 3 | 39 | 2 |
| N | 32 | 1 | - | - | - | - |
| O | - | - | - | - | - | - |
| Approximate Average Pages | | 1.75 | | 1 | | 0.75 |
| Range of Pages | | 0 - 14 | | 0 - 6 | | 0 - 3.5 |
| Number of Books Included Item | 11 | | 3 | | 6 | |
| Median Relative Position | 23.5 | | - | | - | |
| Relative Position of Item, Based on Median | XXI | | - | | - | |

Table 1. (Continued)

| Book | Dynamo Troubles | | Introduction to A.C. | | Eddy Currents | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | - | - | 64 | 12.5 | 52 | 2 |
| B | - | - | 52 | 14 | 38 | 2 |
| C | - | - | 53 | 14 | 46 | - |
| D | - | - | 54 | 10.75 | 47 | 5.5 |
| E | - | - | - | - | - | - |
| F | - | - | 54 | 26 | 49 | 0.5 |
| G | 42 | 20 | - | - | - | - |
| H | 38 | 2.5 | 46 | 8.5 | 62 | 0.5 |
| I | - | - | 11 | 0.25 | 36 | 0.25 |
| J | - | - | 33 | 2 | - | - |
| K | - | - | 5 | 1 | - | - |
| L | - | - | 24 | 3 | - | - |
| M | - | - | 48 | 4 | 58 | 0.25 |
| N | - | - | 11 | 1.5 | - | - |
| O | - | - | 25 | 2.25 | - | - |
| Approximate Average Pages | | 1.5 | | 6.25 | | 0.75 |
| Range of Pages | | 0 - 22 | | 0 - 26 | | 0 - 2 |
| Number of Books Included Item | 2 | | 13 | | 8 | |
| Median Relative Position | - | | 49.25 | | 62.5 | |
| Relative Position of Item, Based on Median | - | | XLIII | | LIII | |

Table 1. (Continued)

| Book | Hysteresis | | Self-Induction | | Metal Inductance | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 53 | 1 | 54 | 5 | 56 | 0.25 |
| B | 30 | 4.5 | 48 | 9.5 | 45 | 2 |
| C | 37 | 2 | 33 | 2 | 30 | 2 |
| D | 32 | 3.5 | 45 | 20.25 | 42 | 10 |
| E | - | - | - | - | - | - |
| F | 35 | 2.5 | 37 | 6 | 38 | 2.5 |
| G | - | - | - | - | - | - |
| H | - | - | 49 | 1.5 | - | - |
| I | 38 | 1 | 35 | 2 | - | - |
| J | - | - | - | - | - | - |
| K | - | - | 66 | 1 | 65 | 0.5 |
| L | - | - | - | - | - | - |
| M | 59 | 2 | 50 | 0.25 | 49 | 1 |
| N | - | - | - | - | - | - |
| O | - | - | - | - | - | - |
| Approximate Average Pages | | 1 | | 3.25 | | 0.5 |
| Range of Pages | | 0 - 4.5 | | 0 - 20.25 | | 0 - 2.5 |
| Number of Books Included Item | 7 | | 9 | | 7 | |
| Median Relative Position | - | | 55 | | - | |
| Relative Position of Item, Based on Median | - | | XLVI | | - | |

Table 1. (Continued)

| Book | Induction Coil | | Power A.C. Circuit | | Power Factor | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 55 | 8.5 | 66 | 1 | 67 | 3 |
| B | 46 | 5.5 | 62 | 1.5 | 63 | 6 |
| C | 31 | 2.5 | 57 | 1.75 | 58 | 2 |
| D | 43 | 1.25 | 63 | 6 | 64 | 8 |
| E | 23 | 5 | - | - | - | - |
| F | 39 | 3 | 60 | 10 | 61 | 0.5 |
| G | 31 | 1.5 | - | - | - | - |
| H | 59 | 1 | 55 | 1.5 | 57 | 1 |
| I | 33 | 10 | - | - | - | - |
| J | 37 | 3 | - | - | - | - |
| K | 58 | 3 | - | - | - | - |
| L | 16 | 12 | - | - | - | - |
| M | 32 | 1.5 | 61 | 0.25 | 60 | 2.5 |
| N | 43 | 0.75 | - | - | - | - |
| O | 31 | 1.5 | - | - | - | - |
| Approximate Average Pages | | 4 | | 1.5 | | 1.5 |
| Range of Pages | | 0.75 - 12 | | 0 - 10 | | 0 - 8 |
| Number of Books Included Item | 15 | | 7 | | 7 | |
| Median Relative Position | 37 | | - | | - | |
| Relative Position of Item, Based on Median | XXXIX | | - | | - | |

Table 1. (Continued)

| Book | Energy Kilowatt Kilowatt Hour Horse Power Watt | | Inductive Reactance Inductance Henry | | Lyden Jar | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 22 | 16.5 | 68 | 3.5 | - | - |
| B | 13 | 8 | 57 | 6.5 | - | - |
| C | 16 | 8 | 54 | 8.5 | 91 | 1 |
| D | 18 | 14 | 46 | 5 | - | - |
| E | 29 | 0.25 | - | - | - | - |
| F | 19 | 5 | 58 | 6 | 42 | 0.25 |
| G | 12 | 11 | - | - | - | - |
| H | 43 | 13 | 51 | 1 | - | - |
| I | 23 | 2.5 | - | - | - | - |
| J | 19 | 2.25 | - | - | 4 | 1 |
| K | 17 | 1 | 16 | 0.75 | 7 | 4 |
| L | 21 | 1 | - | - | 3 | 2 |
| M | 41 | 2.75 | 51 | 3.5 | - | - |
| N | 24 | 3 | 44 | 0.5 | - | - |
| O | 21 | 6 | 58 | 0.25 | 56 | 0.5 |
| Approximate Average Pages | | 6.25 | | 2.5 | | 0.5 |
| Range of Pages | | 0.25-16.5 | | 0 - 8.5 | | 0 - 4 |
| Number of Books Included Item | 15 | | 10 | | 6 | |
| Median Relative Position | 18.80 | | 58 | | - | |
| Relative Position of Item, Based on Median | XIII | | L | | - | |

Table 1. (Continued)

| Book | Impedence in Series Circuits | | Condensers Capacitance | | Capactive Reactance | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 69 | 3.5 | 70 | 5 | 71 | 3.5 |
| B | 59 | 7.25 | 50 | 21 | 58 | 4.5 |
| C | 56 | 1.5 | 59 | 6 | 60 | 3.5 |
| D | 58 | 25 | 60 | 11 | 61 | 0.5 |
| E | - | - | - | - | - | - |
| F | 62 | 13 | 41 | 11.5 | 59 | 6 |
| G | - | - | 29 | - | - | - |
| H | 53 | 2 | 60 | - | - | - |
| I | - | - | - | - | - | - |
| J | - | - | - | - | - | - |
| K | 68 | 2 | 8 | 11 | 67 | 0.5 |
| L | - | - | - | - | - | - |
| M | 53 | 6 | 55 | 5.5 | 56 | 1 |
| N | - | - | - | - | - | - |
| O | - | - | 59 | 0.5 | - | - |
| Approximate Average Pages | | 4 | | 4.75 | | 1.25 |
| Range of Pages | | 0 - 25 | | 0 - 21 | | 0 - 4.5 |
| Number of Books Included Item | 8 | | 10 | | 7 | |
| Median Relative Position | 69 | | 59.83 | | - | |
| Relative Position of Item, Based on Median | LVI | | LI | | - | |

Table 1. (Continued)

| Book | A.C. Values Dectors | | Lag and Lead | | Power Stations Distribution Power Transmission Lines | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 65 | - | 72 | 1.5 | - | - |
| B | 54 | 3 | 56 | 3 | 64 | 6 |
| C | - | - | 55 | - | 72 | 21.5 |
| D | 57 | 14 | 55 | 1 | - | - |
| E | - | - | - | - | 13 | 2 |
| F | 56 | 12 | 55 | 1 | 77 | 17 |
| G | - | - | - | - | - | - |
| H | 47 | 0.25 | 50 | 1 | - | - |
| I | - | - | - | - | - | - |
| J | - | - | - | - | 38 | 4.5 |
| K | - | - | - | - | 43 | 0.5 |
| L | - | - | - | - | - | - |
| M | - | - | 52 | 2 | 70 | 5.5 |
| N | - | - | - | - | - | - |
| O | - | - | - | - | 29 | 37 |
| Approximate Average Pages | | 2 | | 6.25 | | 6.25 |
| Range of Pages | | 0 - 14 | | 0 - 3 | | 0 - 37 |
| Number of Books Included Item | 5 | | 7 | | 8 | |
| Median Relative Position | - | | - | | 79.5 | |
| Relative Position of Item, Based on Median | - | | - | | LXI | |

Table 1. (Continued)

| Book | Electric Shock | | National Electric Code | | Ohm's Law for A.C. | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | - | - | - | - | 73 | 1 |
| B | - | - | - | - | 55 | 1.5 |
| C | - | - | 27 | 0.5 | 61 | 0.25 |
| D | - | - | - | - | 59 | 3.5 |
| E | - | - | - | - | - | - |
| F | - | - | - | - | 57 | 2 |
| G | - | - | Mentioned at end | | - | - |
| H | 24 | 0.5 | 28 | 0.25 | 52 | 0.5 |
| I | - | - | - | - | - | - |
| J | - | - | - | - | - | - |
| K | - | - | 29 | 1.5 | - | - |
| L | 42 | 4.5 | 45 | 0.25 | - | - |
| M | - | - | - | - | 54 | 1 |
| N | - | - | 49 | - | - | - |
| O | - | - | 36 | 0.5 | - | - |
| Approximate Average Pages | | 0.25 | | 0.25 | | 0.5 |
| Range of Pages | | 0 - 4.5 | | 0 - 1.5 | | 0 - 3.5 |
| Number of Books Included Item | 2 | | 6 | | 7 | |
| Median Relative Position | - | | - | | - | |
| Relative Position of Item, Based on Median | - | | - | | - | |

Table 1. (Continued)

| Book | Impedence in Parallel Circuits | | Pollyphase Circuits and Systems | | Power in Pollyphase | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 74 | 5.5 | 75 | 4 | 76 | 3 |
| B | 60 | 13 | 65 | 6 | 66 | 4 |
| C | - | - | 63 | 1 | 64 | 1 |
| D | 62 | 8.5 | 65 | 9 | 68 | 1.5 |
| E | - | - | - | - | - | - |
| F | 63 | 6.5 | 66 | 8 | 68 | 6 |
| G | - | - | - | - | - | - |
| H | 54 | 1 | 67 | 5 | 69 | 3 |
| I | - | - | 25 | 5 | - | - |
| J | - | - | - | - | - | - |
| K | - | - | 50 | 0.25 | - | - |
| L | - | - | - | - | - | - |
| M | - | - | 66 | 1 | - | - |
| N | - | - | - | - | - | - |
| O | - | - | - | - | - | - |
| Approximate Average Pages | | 2.25 | | 2.5 | | 1.25 |
| Range of Pages | | 0 - 13 | | 0 - 9 | | 0 - 6 |
| Number of Books Included Item | 5 | | 9 | | 6 | |
| Median Relative Position | - | | 66.83 | | - | |
| Relative Position of Item, Based on Median | - | | LIV | | - | |

Table 1. (Continued)

| Book | Electric Filters | | Transformer | | A.C. Generator Alternator | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 77 | 1.5 | 78 | 8 | 79 | 6 |
| B | 61 | 4 | 47 | 1.5 | 53 | 5.5 |
| C | - | - | 66 | 17 | 62 | 10 |
| D | - | - | 69 | 20 | 56 | 21 |
| E | - | - | 24 | 3 | - | - |
| F | - | - | 70 | 38 | - | - |
| G | - | - | - | - | - | - |
| H | - | - | 58 | 15.5 | 48 | 4.25 |
| I | - | - | 37 | 24 | - | - |
| J | - | - | 36 | 3 | - | - |
| K | - | - | 48 | 3.5 | 40 | 2 |
| L | - | - | 25 | 1.25 | 29 | 0.5 |
| M | - | - | 57 | 12 | 36 | 1.25 |
| N | - | - | 42 | 5 | 37 | 4 |
| O | - | - | 30 | 8 | 27 | 7 |
| Approximate Average Pages | | 0.25 | | 10.5 | | 4 |
| Range of Pages | | 0 - 4 | | 0 - 38 | | 0 - 21 |
| Number of Books Included Item | 2 | | 14 | | 10 | |
| Median Relative Position | - | | 49.5 | | 55 | |
| Relative Position of Item, Based on Median | - | | XLIV | | XLVII | |

Table 1. (Continued)

| Book | Synchronous or Rotary Converter | | Rectifiers | | Polly Phase Induction Motor | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 80 | 4 | 81 | 6 | 82 | 7 |
| B | 69 | 1.5 | 75 | 8 | 68 | 3 |
| C | 73 | 3 | 75 | 3 | 68 | 10.5 |
| D | 40 | - | - | - | - | - |
| E | - | - | - | - | - | - |
| F | 75 | 10.5 | 76 | 5.5 | 71 | 28 |
| G | - | - | - | - | - | - |
| H | - | - | 65 | 2 | 72 | 6 |
| I | - | - | 42 | 3 | - | - |
| J | - | - | 48 | 1 | - | - |
| K | 47 | 0.25 | - | - | 49 | 0.5 |
| L | - | - | - | - | - | - |
| M | - | - | 62 | 3.75 | 64 | 4 |
| N | - | - | - | - | 39 | 1.5 |
| O | 33 | 1 | - | - | 40 | - |
| Approximate Average Pages | | 1.5 | | 2.25 | | 4 |
| Range of Pages | | 0 - 10.5 | | 0 - 8 | | 0 - 28 |
| Number of Books Included Item | 7 | | 8 | | 9 | |
| Median Relative Position | - | | 82 | | 73.25 | |
| Relative Position of Item, Based on Median | - | | LXIII | | LVIII | |

Table 1. (Continued)

| Book | Polly Phase Motor Starters | | Single Phase Motors | | Synchronous Motors | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 83 | 4 | 84 | 6 | 85 | 3 |
| B | - | - | - | - | - | - |
| C | 71 | 1.5 | 69 | 6.5 | 70 | 3.5 |
| D | - | - | - | - | 41 | - |
| E | - | - | - | - | - | - |
| F | 72 | 5 | 73 | 11 | 74 | 19 |
| G | - | - | - | - | - | - |
| H | 73 | 1 | 63 | 3 | 64 | 0.25 |
| I | - | - | 24 | 3 | - | - |
| J | - | - | - | - | - | - |
| K | - | - | 46 | 1 | - | - |
| L | - | - | - | - | 30 | 0.25 |
| M | 67 | 1 | 63 | 3 | 68 | 3 |
| N | - | - | 38 | 1.5 | 40 | - |
| O | - | - | 41 | - | - | - |
| Approximate Average Pages | | 0.75 | | 2.25 | | 2 |
| Range of Pages | | 0 - 5 | | 0 - 11 | | 0 - 19 |
| Number of Books Included Item | 5 | | 9 | | 8 | |
| Median Relative Position | - | | 73.5 | | 87.5 | |
| Relative Position of Item, Based on Median | - | | LIX | | LXIV | |

Table 1. (Continued)

| Book | Motor-Generator Sets | | Static Electricity Electro-Static Electric Charges | | Electron Theory | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 86 | 1.5 | 87 | 7 | 88 | 2 |
| B | - | - | 78 | 19 | 40 | 0.5 |
| C | 74 | - | - | - | 92 | 1.5 |
| D | - | - | 14 | - | 1 | 24 |
| E | - | - | - | - | 8 | 1 |
| F | - | - | 40 | 12 | 82 | 3 |
| G | - | - | - | - | 33 | 1 |
| H | - | - | 17 | 1.5 | 3 | - |
| I | 41 | 0.5 | - | - | - | - |
| J | 47 | - | 2 | 2.5 | - | - |
| K | - | - | 6 | 22 | 4 | 6.5 |
| L | - | - | 2 | 8.25 | - | - |
| M | - | - | - | - | 2 | 1.5 |
| N | - | - | 2 | 3.5 | 3 | 3 |
| O | 32 | 1.25 | 1 | 3 | 10 | - |
| Approximate Average Pages | | 0.5 | | 5.25 | | 3 |
| Range of Pages | | 0 - 2.5 | | 0 - 22 | | 0 - 24 |
| Number of Books Included Item | 5 | | 10 | | 12 | |
| Median Relative Position | - | | 35.5 | | 35.5 | |
| Relative Position of Item, Based on Median | - | | XXX | | XXXI | |

Table 1. (Continued)

| Book | Radio Tubes Vacuum Tubes and Applications | | X-Ray X-Ray Tubes and Other Equipment | | Photo-Electric Cell | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 91 | 4.5 | 89 | 4 | - | - |
| B | 70 | 28 | 71 | 2.5 | 72 | 4.5 |
| C | - | - | 95 | 11.5 | - | - |
| D | - | - | - | - | - | - |
| E | 36 | 17 | - | - | 39 | 1 |
| F | 83 | 28 | 84 | 0.5 | - | - |
| G | 36 | 8 | - | - | - | - |
| H | 74 | 3.5 | - | - | - | - |
| I | - | - | - | - | - | - |
| J | 42 | 4 | 45 | 3 | - | - |
| K | 61 | 4.25 | 64 | - | - | - |
| L | - | - | 17 | 1 | - | - |
| M | - | - | - | - | - | - |
| N | - | - | - | - | - | - |
| O | 57 | 9 | - | - | - | - |
| Approximate Average Pages | | 5.5 | | 1.5 | | 0.25 |
| Range of Pages | | 0 - 28 | | 0 - 11.5 | | 0 - 4.5 |
| Number of Books Included Item | 9 | | 7 | | 2 | |
| Median Relative Position | 79.5 | | - | | - | |
| Relative Position of Item, Based on Median | LXII | | - | | - | |

Table 1. (Continued)

| Book | Three Phase Alternator | | Telegraphy | | Y and Delta Connections | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 66 | 7 | 92 | 13 | 65 | 2 |
| B | - | - | - | - | 67 | 4 |
| C | 65 | 2.5 | 25 | 4.5 | 67 | 3 |
| D | - | - | 30 | 1 | 56 | 5 |
| E | - | - | 5 | 7 | - | - |
| F | 69 | 57 | 4 | 0.5 | 67 | 8 |
| G | - | - | 34 | 3 | - | - |
| H | 68 | 3.25 | - | - | 70 | 2 |
| I | 36 | 1.5 | 20 | 0.25 | - | - |
| J | 31 | - | 13 | 16.5 | - | - |
| K | - | - | 56 | 1.5 | - | - |
| L | - | - | 14 | 18 | - | - |
| M | - | - | 12 | 1.25 | 65 | 0.75 |
| N | - | - | - | - | - | - |
| O | - | - | - | - | - | - |
| Approximate Average Pages | | 4.75 | | 4.5 | | 1.75 |
| Range of Pages | | 0 - 57 | | 0 - 18 | | 0 - 8 |
| Number of Books Included Item | 6 | | 11 | | 7 | |
| Median Relative Position | - | | 28 | | - | |
| Relative Position of Item, Based on Median | - | | XXVI | | - | |

Table 1. (Continued)

| Book | Three Phase Three Phase Four Wire | | Auto Ignition Auto Systems | | Telephone and Systems | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | - | - | 51 | 1.5 | 93 | 14.5 |
| B | - | - | - | - | - | - |
| C | - | - | 32 | 0.5 | 89 | 15 |
| D | 67 | 1.25 | 44 | - | 31 | - |
| E | - | - | - | - | 25 | 10 |
| F | - | - | 53 | 7 | - | - |
| G | - | - | 32 | 1 | 35 | 3 |
| H | 71 | 6 | 61 | 2 | 75 | 1.5 |
| I | 27 | 2 | - | - | 21 | 0.25 |
| J | - | - | 39 | 8.5 | 26 | 15 |
| K | - | - | 59 | 3.5 | 57 | 5 |
| L | - | - | - | - | 15 | 13 |
| M | - | - | 33 | - | - | - |
| N | - | - | - | - | - | - |
| O | - | - | - | - | 52 | 4 |
| Approximate Average Pages | | 0.5 | | 1.5 | | 5.5 |
| Range of Pages | | 0 - 6 | | 0 - 8.5 | | 0 - 15 |
| Number of Books Included Item | 3 | | 9 | | 11 | |
| Median Relative Position | - | | 57.5 | | 58 | |
| Relative Position of Item, Based on Median | - | | XLVIII | | L | |

Table 1. (Continued)

| Book | Telephotography Radio Phone | | Wireless Radio Transmission | | Radio Reception | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 94 | 2 | 90 | 17.5 | 97 | 18 |
| B | - | - | - | - | - | - |
| C | - | - | 92 | 11 | 93 | 5 |
| D | - | - | - | - | - | - |
| E | - | - | 35 | 8.5 | 37 | 11 |
| F | - | - | - | - | 85 | 5 |
| G | - | - | - | - | - | - |
| H | - | - | - | - | 77 | 6 |
| I | - | - | - | - | - | - |
| J | - | - | 41 | 2.5 | - | - |
| K | - | - | 62 | 7 | 58 | 18.5 |
| L | - | - | 18 | 0.25 | - | - |
| M | - | - | - | - | - | - |
| N | - | - | - | - | - | - |
| O | 60 | 3 | 54 | 4 | 55 | 18 |
| Approximate Average Pages | | 0.25 | | 3.5 | | 5. |
| Range of Pages | | 0 - 3 | | 0-17.5 | | 0-18.5 |
| Number of Books Included Item | 2 | | 7 | | 7 | |
| Median Relative Position | - | | - | | - | |
| Relative Position of Item, Based on Median | - | | - | | - | |

Table 1. (Continued)

| Book | Television | | Arc Lamps Arcs | | Gaseous Conduction Ionization | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | - | - | 48 | 3 | 73 | 10 |
| B | 74 | 2 | 74 | 4.5 | 94 | 3.5 |
| C | - | - | 80 | 3.5 | - | - |
| D | - | - | - | - | - | - |
| E | 38 | 11 | - | - | - | - |
| F | - | - | 81 | 2 | - | - |
| G | - | - | - | - | - | - |
| H | - | - | - | - | - | - |
| I | - | - | - | - | - | - |
| J | - | - | 28 | 3 | - | - |
| K | - | - | - | - | - | - |
| L | - | - | 32 | 4 | - | - |
| M | - | - | - | - | - | - |
| N | - | - | - | - | - | - |
| O | - | - | - | - | - | - |
| Approximate Average Pages | | 1 | | 1.5 | | 1 |
| Range of Pages | | 0 - 11 | | 0 - 4.5 | | 0 - 10 |
| Number of Books Included Item | 2 | | 6 | | 2 | |
| Median Relative Position | - | | - | | - | |
| Relative Position of Item, Based on Median | - | | - | | - | |

Table 1. (Continued)

| Book | Corona | | Incandescent Lamp Lighting | | Mercury Vapor and Vapor Lamps | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 97 | 1 | 47 | 6 | 46 | 2 |
| B | 76 | 1 | - | - | - | - |
| C | - | - | 79 | 10 | 81 | 1 |
| D | - | - | - | - | - | - |
| E | - | - | 33 | 8.5 | - | - |
| F | - | - | 80 | 1.25 | - | - |
| G | - | - | - | - | - | - |
| H | - | - | - | - | - | - |
| I | - | - | - | - | - | - |
| J | - | - | 27 | 12 | 29 | 2.5 |
| K | - | - | 54 | 1 | - | - |
| L | - | - | 31 | 8 | - | - |
| M | - | - | - | - | - | - |
| N | - | - | 46 | 1 | - | - |
| O | - | - | 49 | 11 | - | - |
| Approximate Average Pages | | - | | 4 | | 0.5 |
| Range of Pages | | 0 - 1 | | 0 - 11 | | 0 - 2.5 |
| Number of Books Included Item | 2 | | 9 | | 3 | |
| Median Relative Position | - | | 77.5 | | - | |
| Relative Position of Item, Based on Median | - | | LX | | - | |

Table 1. (Continued)

| Book | Illumination | | Circuit Breaker | | Elevators, Clocks Locomotives, Automobiles, Ships, Household Apparatus | |
|---|---|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 48 | 3 | 28 | 1 | - | - |
| B | - | - | 28 | - | 88 | 20 |
| C | 82 | 11 | 84 | 1 | - | - |
| D | - | - | - | - | - | |
| E | - | - | - | - | - | - |
| F | 79 | 6.5 | 52 | 1 | - | - |
| G | - | - | - | - | - | - |
| H | - | - | 23 | 1 | - | - |
| I | - | - | - | - | 46 | )1*<br>)2 |
| J | - | - | - | - | - | - |
| K | - | - | - | - | - | - |
| L | - | - | - | - | - | - |
| M | - | - | 45 | 0.25 | - | - |
| N | - | - | - | - | - | - |
| O | 50 | 24 | - | - | 42 | 9* |
| Approximate Average Pages | | 3 | | 0.25 | | 1.5 |
| Range of Pages | | 0 - 24 | | 0 - 1 | | 0 - 20 |
| Number of Books Included Item | 4 | | 6 | | 3 | |
| Median Relative Position | - | | - | | - | |
| Relative Position of Item, Based on Median | - | | - | | - | |

*Household devices, such as flat iron.

Table 1. (Concluded)

| Book | Electro-Magnetic Waves Waves | | Introduction to Radio | |
|---|---|---|---|---|
| | Relative Position of Item | Number Pages Each Item | Relative Position of Item | Number Pages Each Item |
| A | 95 | 7 | - | - |
| B | - | - | - | - |
| C | 90 | 12.5 | - | - |
| D | - | - | - | - |
| E | - | - | 34 | 10 |
| F | - | - | - | - |
| G | - | - | - | - |
| H | - | - | 76 | 4.5 |
| I | - | - | - | - |
| J | 40 | - | 43 | 1 |
| K | 63 | 6.5 | 60 | 1 |
| L | - | - | - | - |
| M | - | - | - | - |
| N | - | - | - | - |
| O | 53 | 3 | 51 | 4.5 |
| Approximate Average Pages | | 2 | | 1.5 |
| Range of Pages | | 0 - 12.5 | | 0 - 10 |
| Number of Books Included Item | 5 | | 5 | |
| Median Relative Position | - | | - | |
| Relative Position of Item, Based on Median | - | | - | |

The following table, Table 2, gives the order of items and the number of pages devoted to each, based on the median of the item and the mean of the pages of the fifteen books analyzed, as shown at the bottom of the page in Table 1, beginning on page 9.

For example, reading the first line across in Table 2, "I" indicates that the first topic discussed, based on information obtained as stated in the above paragraph, is, "Introduction to Electricity." The pages devoted to this topic are 5.25.

Reading the last line across in this table, "Synchronous Motors" is the sixty-fourth topic discussed, and the space devoted to it was 2 pages.

Table 2. Order of Topics and Number of Pages Devoted to Each, Based on Median of Items and Mean of Pages as Indicated in Table 1.

| Order | Number of Pages | Title |
|---|---|---|
| I | 5.25 | Introduction to Electricity. |
| II | 4.5 | Permanent Magnets and Magnets. |
| III | 7.25 | Primary Cells. |
| IV | 2.5 | Conductance. Resistance. |
| V | 7. | Magnetism. |
| VI | 1. | Volts. |
| VII | 2.25 | Amperes and Current. Measure Current. |
| VIII | 4.5 | Voltaic Cell. Simple Electric Cell. Electro-Chemistry. |
| IX | 1. | Electro Motive Force. Potential. |
| X | 0.25 | Coulomb. |
| XI | 3.75 | Ohm. Ohm's Law. |
| XII | 1.5 | Conductors. Insulators. |
| XIII | 6.25 | Energy. Kilo-watt. Watt. Horse Power K.W.H. |
| XIV | 2.5 | Series Circuit. |
| XV | 4.5 | Battery Connections. Ohm's Law for Batteries. |
| XVI | 2. | Heating Effect of a Current. |
| XVII | 3.25 | Parallel Circuits. |
| XVIII | 4. | Magnetic Effect of a Current. Electro Magnetic. Electro Magnetism. |

Table 2. (Continued)

| Order | Number of Pages | Title |
|---|---|---|
| XIX | 4.75 | Solenoid Electro Magnet. |
| XX | 3.75 | Ammeters. Milli-Ammeters. |
| XXI | 1.75 | Volts Drop. Line Drop. Measure Volts |
| XXII | 4.25 | Circular Mil. Resistance of a Wire. Wires. |
| XXIII | 3.75 | Bells. Signalling Devices. Bell Wiring. |
| XXIV | 12. | Storage Battery. |
| XXV | 2. | Voltmeter. Milli-Voltmeter. |
| XXVI | 4.5 | Telegraphy. |
| XXVII | 1.75 | Heating Effect of Current. Capacity of Wire. Tables. |
| XXVIII | 5.25 | Electro Magnetic Induction. Lenz's Law. |
| XXIX | 2. | Galvanometer. |
| XXX | 5.25 | Static Electricity. Electro Static. Electric Charges. |
| XXXI | 3. | Electron Theory. |
| XXXII | 5.75 | Electro Dynamics. Introduction to Motors. |
| XXXIII | 1.25 | Fuses. |
| XXXIV | 4. | Induction Coil. |
| XXXV | 0.75 | Measure Resistance with Voltmeter and Ammeter. |
| XXXVI | 14.5 | Generator. D.C. Generator. |
| XXXVII | 6.5 | Magnetic Circuits and Windings. |
| XXXVIII | 3.5 | Chemical Effects of a Current. Electroplating. |
| XXXIX | 3.5 | Dynamo D.C. Machinery. |
| XL | 2.5 | Watt Hour Meter. Calculate Cost from Readings. |
| XLI | 13.5 | D.C. Motors, Starters and Switches. |
| XLII | 2.25 | Heating Devices. |
| XLIII | 6.25 | Introduction to A.C. |
| XLIV | 10.5 | Transformers. |
| XLV | 0.75 | Efficiency. |
| XLVI | 3.25 | Self Induction. |
| XLVII | 4. | A.C. Alternator or A.C.Generator. |
| XLVIII | 1.5 | Auto Ignition and Auto Systems. |
| XLIX | 2.5 | Inductive Resistance. Henry. |
| L | 5.5 | Telephone and Systems. |
| LI | 5. | Condensers. Capacitance. |
| LII | 1. | Watt Meters. |

Table 2. (Concluded)

| Order | Number of Pages | Title |
|---|---|---|
| LIII | 0.75 | Eddy Currents. |
| LIV | 2.5 | Polly Phase Circuits and Systems. |
| LV | 3.25 | Three Wire Systems, Single Phase, or D.C. |
| LVI | 4. | Impedence in Series Circuits. |
| LVII | 5.75 | Interior Wiring. House Wiring. Wiring Devices. |
| LVIII | 0.75 | Polly Phase Motors and Starters. |
| LIX | 2.25 | Single Phase Motors. |
| LX | 4. | Incandescent Lamps. Lighting. |
| LXI | 6.25 | Power Stations. Distribution of Power. Transmission Power. |
| LXII | 5.5 | Radio Tubes. Vacuum Tubes and Applications. |
| LXIII | 2.25 | Rectifiers. |
| LXIV | 2. | Synchronous Motors. |

## DISCUSSION OF FINDINGS AS INDICATED IN TABLES 1 AND 2

In the original analysis the writer had one hundred and thirteen items, selected with no thought of arrangement according to importance and with no attempt to include only fundamentals. However, after the median of all items and the mean of pages devoted to each item had been found, it was expected that the answers to these five questions could be arrived at:

1. What are the fundamentals of electricity?

2. What are the apparatus, devices, machines, etc., used either because of aid in presentation of fundamentals or used so commonly by everyone that anyone with a knowledge of electricity should understand them?

3. What is the order in which questions 1 and 2 should be discussed?

4. What is the amount of space which should be devoted to questions 1 and 2?

5. What are the items which should be eliminated from the book, but which were considered important by an individual author?

The next point to be considered was to what extent the analysis had aided in finding things which should be accomplished. A person would be inclined to accept the opinions of the majority of the fifteen authors as to what should be included in a text, but findings are not to be interpreted as the answers to the five questions previously stated of what a book should contain, until the items are scrutinized very closely.

Consider first Item III,[1] "Primary Cells." This includes "dry cells" and "wet cells." There is nothing in a textbook on this subject[2] that would indicate that primary cells can be classed as fundamentals. They are increasingly unimportant sources of electrical energy. A knowledge of them is not essential to instruction. In the Rindge Technical High School in Cambridge, Massachusetts, there is not one primary cell used in any of the twenty laboratories devoted to the study of science, physics, chemistry and electricity. A few years ago they were the chief source of energy for experimental purposes. The use of primary cells in almost every field in which they were used formerly has decreased enormously. From 1923 to 1929 the number of batteries produced for radio use alone was 387,345,863.[3] The invention of all-electric radios since that time has eliminated that battery field almost entirely. The chief use of the dry battery now is in the flash

1/ See Table 2, p.47.

2/ Park, Benjamin, Electric Batteries.

3/ Fifteenth Census of U.S. Manufactures, 1929, XX, Table 8, p.1128.

light.[1] Therefore, common sense prevents a lengthy discussion in a book, of anything as simple as this type of battery.

Western Union used "wet batteries" extensively until recently, but today they use very few.[2]

Further proof that primary batteries are no longer an essential source of energy is contained in two letters received by the writer from very reliable sources.[3] These may be found in the appendix.

Sufficient evidence has been given to show that a study of the primary cell should not occupy a prominent space in a book, nor should a mean of seven pages be devoted to it. Maintenance, installation, and uses are all that are necessary to know concerning primary cells.

There is no argument that can be used to justify the treatment of item VIII (Voltaic Cell - 4.5 pages) in any electricity book. This is included in practically every physics book.[4] It is really an introduction to item III (Primary Cells), which has just been discussed.

The next item the writer will consider is item XXIV (Storage Battery).

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1/ Fifteenth Census of U.S. Manufactures, 1929, XX, Table 8, p.1128.

2/ Personal letters from J.H.Groves, Superintendent, Western Union Telegraph Co., dated April 1 and 13, 1938.

Personal letter from H.Burkland, Manager, Bryant Mfg. Co., dated March 24, 1938.

3/ Personal letter from E.Val Wetmore, Manager, Wetmore Savage Co., dated April 2, 1938.

Personal letter from A.A.Church, in charge of N.E. Signal Sales Division of Holtzer-Cabot Co., dated April 7, 1938.

4/ Black and Davis, Practical Physics, p.262-269.

This comes twenty-fourth on the list,[1] and it is discussed in all fifteen books. Its range is from 2.5 to 42.5 pages and it has a mean of 12 pages. The United States Bureau of Census shows that production was valued at approximately $46,000,000. for 1935 and about one-fifth of this amount was used for motor vehicles. The writer's investigation of the uses of the storage battery has shown that its use is increasing rapidly and that it is extensively employed in telephone,[2] telegraph,[3] railroad signalling,[4] and United States Government Marine work.[5]

Regardless of the fact that its use is increasing, as shown by this data, the writer contends that the storage battery is placed too prominently in the list and that too much space is devoted to it, because a discussion of it cannot be classed as fundamental, nor as an aid in presenting a fundamental.

Too much stress is laid on chemical action and repairing. The former belongs to the field of chemistry [6] and the latter is being replaced by the "exchange plan." In the classified section of the Boston telephone directory the writer found the advertisement of only one company that men-

1/ See Table 2, p.48.

2/ Personal Letter from F.A.Shurtleff, Manager of New England Telephone and Telegraph Co., dated April 4, 1938.

3/ Personal Letter from J.H.Groves, Superintendent of Western Union Telegraph Co., dated April 13, 1938.

4/ Personal Letter from H.F.Brown,Chairman of Association of American Railroads, dated April 5, 1938.

5/ Personal Letter from E.H.Evans, Sales Promotion Manager of Willard Storage Battery Company, dated April 6, 1938.

6/ Norris, James F., Inorganic Chemistry, p.486-496.

tioned battery repairing. A reference to a good text 1/ on the subject and a suggestion that the reader write to any of the leading manufacturers of storage batteries 2/ for a pamphlet on instructions (the Electric Storage Battery Company of Philadelphia has a very fine one), together with a few pages of general information are all that is needed. There are changes being made in storage battery construction, and a book that goes too much into detail is liable soon to become obsolete. The writer did not find in any of the fifteen books a reference to the "Low Discharge Storage Battery" 3/ that is now being used so extensively in many fields.

This item on storage batteries was discussed to show that the position of an item or the amount of space devoted to it should not be based on the number of practical apparatus used or their commercial value, but on the value of the item as a fundamental and as a tool to aid in the presentation of principles involved in the fundamental.

The next item to be discussed, number XXVI (Telegraphy) 4/ is a typical example of obsolete material in a textbook which is retained, no doubt, because of its historical value.5/ Telegraphy, in 1844, created the first commercial use for electricity,6/ but Western Union and many railroads have

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1/ Morton, Ardent, Storage Battery.

2/ Buyers Reference Number, Electrical World, Part II (1937), p.15.

3/ Low Discharge Battery, Willard Storage Battery Company.

4/ See Table 2, p.48.

5/ Thompson, S.P., Electricity and Magnetism, p.393-403.

6/ Morgan, Alfred, A First Electricity Book, p.67.

discontinued the use of the telegraphic instrument.[1]

By consulting item L (Telephone) in Table 1 it can be seen readily that this is over-emphasized. There has been such a radical change in telephone apparatus in the past few years that it is absurd to give the subject, in an elementary text, anything more than passing notice, regardless of the fact that many apartments still use the old type of telephone. A glance at a text written twelve years ago [2] and at one of recent date [3] will prove this contention. The science of the telephone is a highly specialized field and one has only to visit the New England Telephone and Telegraph Company's station on Ware Street, Cambridge, Massachusetts, to be convinced of this.

The original items were reduced from one hundred and thirteen to sixty-four [4] and the question arises as to whether or not the items eliminated were of no real value in a textbook.

A close scrutiny of Table 1 shows that there are included in the discarded list [5] some items that should not have been omitted. The writer refers to the circuit breaker as an example. Only six authors mentioned it, and the mean of pages devoted to it is only 0.3. This lack of emphasis is due to recent developments that have been made in this device. Until re-

1/ Personal letters from J.H.Groves, Superintendent of Western Union Telegraph Co., dated April 1 and 13, 1938.

2/ Jansky and Faber, Principles of Telephone, Part I, p.160.

3/ Smith and Campbell, Automatic Telephone.

4/ See Table 2, p.47-49.

5/ Those items in Table 1, p.9-46, for which there is no "Relative Position Based on Median" given.

cently fuses had to be used to protect circuits in homes, in offices, and in experimental laboratories, but now they may be replaced by circuit breakers.[1] Hence this device becomes a very vital piece of apparatus in the electrical field, especially in the home. Therefore it should be discussed at length.

The contents of an electricity book in a broad sense deal with two general topics: direct current and alternating current. The early developments were in direct current, but from the opening of the first generating plant [2] to this day the trend has been towards the use of alternating current. However, elementary textbooks, with almost no exception, have devoted much more of their contents to a discussion of direct current. The only excuse given is that a knowledge of direct current is advisable as a basis for the study of alternating current.[3] Even so, there is no reason why textbooks should devote most of their attention to that which is basic. The index of a recent electrical engineering book [4] has one line for direct current as compared with seven lines for alternating current. Again, in another book [5] one hundred and six index references were found under

1/ General Electric Branch Circuit Breaker, MD-3.7, p.1-3.
Westinghouse Nofag Multi-Breaker, Cat. 29-300.

2/ First electrical generating station was opened in 1882, Public Utility Service, 1927.

3/ Personal letter from G.F.Wittig, Statistical Editor of Electrical World, dated April 12, 1938.

Personal letter from Chester L. Dawes, Associate Professor, Harvard University, dated April 20, 1938.

4/ Eshbach, Handbook of Engineering.

5/ Electric Engineering Handbook, Electric Power, Part IV.

headings referring to alternating current, while under headings referring to direct current, there were merely thirty-eight. The authors of elementary textbooks have failed to follow the example of writers of electrical engineering texts.

Only about three per cent 1/ of the energy (120,996,000,000 kilowatt hours) 2/ generated in this country is done so by direct current, and of the energy used only about ten per cent is direct current.3/ The trend in railroading in the past few years has been away from direct current and toward alternating current.4/ The New England Power Association sold only 0.3 per cent of its 1,971,331,997 kilowatt hour output in 1937 as direct current.5/ The Philadelphia Electric Company discontinued its supply of direct current to its customers in October, 1935.6/ In Cambridge, Massachusetts, only alternating current is supplied to consumers, and Boston proper, which was formerly on direct current, is changing rapidly to alternating current. No figures were obtainable from the Edison Electric Company of Boston, but the writer knows that direct current represents but a

1/ Personal letter from William M. Carpenter, Economist, Edison Electric Institute, dated April 2, 1938.

2/ Federal Power Commission Report on Production of Electricity, Release Number 366.

3/ Personal letter from William M. Carpenter, Economist, Edison Electric Institute, dated April 2, 1938.

4/ Personal letter from H.F.Brown, Chairman, Association of American Railroads, dated April 5, 1938.

5/ Personal letter from H.Hanson, Treasurer, New England Power Association, dated April 11, 1938

6/ Personal letter from H.B.Bryans, Vice President, Philadelphia Electric Company, dated March 29, 1938.

small percentage of its total load. The vast majority of this company's customers are supplied with alternating current.

The United States Navy, prior to 1934, used direct current exclusively for lighting and for auxiliary equipment on ships. All the seventy-seven ships built since that date have the alternating current system of miscellaneous and auxiliary electrification.[1/]

The writer believes he has given data enough to prove that the fifteen books read, in which emphasis as shown in Tables 1 and 2 was decidedly on direct current, were wrong in their proportion of space and items devoted to direct current as against that devoted to alternating current.

The writer stated at the beginning of this thesis that an electricity textbook should emphasize not just any device that is familiar to the author, but only those devices and apparatus that are in common, everyday use. The textbooks analyzed, as shown in Table 1 under the heading of heating devices and household apparatus (included under heading with elevators, etc.) have placed very little emphasis on these. This is a grave mistake. Books on electrical apparatus and appliances,[2/] and authorities on the subject reveal their importance,[3/] as does also a study of the following data.

In 1937 there were more than 26,000,000 customers in the United States

---

1/ General Electric Company, Studies in Engineering, Number 208, p.6.

2/ Gay, C.M., Electric Apparatus and Appliances.

3/ Muir, R.C., Some Engineering Contributions to Society, p.1-11.

that had electrical service.[1] Approximately 900,000 of these were farm dwellers and approximately 21,000,000 were residential consumers.[2] These figures show that it would be much more sensible to give more attention to electrical equipment used by those customers, who comprise eighty-four per cent of the total, and less to equipment that is used only in connection with highly specialized fields, such as X-ray work, power station equipment and the like.

A study of the use of appliances reveals that for the year 1937 [3] fifteen different classes of electrical appliances were being operated for domestic purposes, and that the total number of the same in use was 11,454,175,000.[4] Such a universal use of appliances calls for far more attention to their construction, installation, maintenance and safety in elementary textbooks than is given now.

The question here arises as to whether or not a text should include a discussion of safety against electrical hazards. If the author were guided by the opinion of the majority of the writers of the books analyzed, he would omit it. Here again this writer disagrees. The many rules and regulations and the many articles written about the subject are indications of its importance. The National Board of Fire Underwriters publishes a book [5]

1/ Federal Power Commission and Its Work, 1933-1937.

2/ Edison Electric Institute Bulletin, Number 4 (January, 1937), The Electric Light and Power Industry in the United States, p.40-42.

3/ Loc. cit.

4/ Edison Electric Institute, Energy Used by Domestic Appliances.

5/ National Board of Fire Underwiters, National Electric Code, 1937, p.334.

of regulations for electrical wiring and apparatus, and an intimate knowledge of its contents is required by every state before an electrician's license is issued to him. Yet only six authors referred to this topic, and the average space devoted to it was one-quarter of a page. Dr. Copeland's article, "Shocks from Electricity Serious," which appeared in the Boston Evening American, March 25, 1938, is a very convincing argument for the adoption of safety as an essential topic to be included in an electricity book.

"As civilization has advanced more and more, hazards and dangers to life have appeared.

"We recognize the great mechanical and social advantages of electricity. But in a recent publication of an insurance company, it is pointed out that electricity was responsible in 1934 for more than 600 deaths in the United States.

"It is true that many of these fatalities occurred among electrical linemen, electricians and workers engaged in installing high power machinery. Some were caused by electric burns. Some involved high voltage exposure. Others occurred as a result of contact with the ordinary household current. There is a universal belief that the low voltage so commonly found in homes is not dangerous. The ordinary household current of 100 to 110 volts is not in itself a dangerous current. But occasionally it may be of sufficient intensity to cause severe damage to the heart and produce instant death.

"TO MANY CARELESS

"Many of these accidents could have been avoided. Too many persons are careless about the handling of electrical appliances. It is customary to assume that electrical equipment is always in perfect order. But we must not overlook the fact that with constant use wires become frayed and damaged. Conditions result which are capable of producing short circuits, and these make the appliance dangerous and prepare the way for electric shock.

"It is unwise to handle electrical equipment while the hands or other parts of the body are wet. A dry skin serves as a barrier against the electrical current. But a moist skin lowers this resistance and a wet skin acts as an excellent conductor.

"Many deaths have been reported of persons who received fatal shocks in handling electrical apparatus, while in the bathtub or before drying. I am glad to say that definite efforts are now being made to prevent these deaths. But emphasizing the danger, the public is coming to realize the importance of caution.

"Electrical appliances should be checked and serviced by licensed electricians. This practice will increase the life of the appliances and prevent conditions favorable to direct contacts with the current."

Good books and articles to read in guiding an author as to what should be included in a text on this subject of safety are the following: Injury from Electricity,[1] Don'ts for Electrical Pupils,[2] Electricity and Fire Risk,[3] Industrial Code of Department of Vocational Education,[4] Resusitation,[5] Electrical Injuries,[6] Safety for the Household.[7]

A critical analysis, such as is given in this discussion of ten items selected from Tables 1 and 2, should be made of all one hundred and thirteen items. Not until then can an accurate standard for an elementary electricity text be established. This would involve much more study and space than can be given to it in a preliminary report such as this. But until such time as that is done, the data given in Tables 1 and 2 will be found very helpful.

---

1/ Science, No. 83, Supplement 9, May 15, 1936.

2/ Flaherty, E.B., Industrial Art and Vocational Education, XXIII (March, 1934), p.132.

3/ Hodges, E.S., Electricity and Fire Risk.

4/ State Department of Education, Bulletin Number 19, New York City.

5/ Lauffer, Charles A., Resuscitation, p.90.

6/ Circular of Bureau of Standards, Number 397, United States Department of Commerce.

The following table reveals data concerning the content other than subject matter of the fifteen books analyzed.

Table 3. Contents of Fifteen Books Analyzed for other than Subject Matter

| Book | Number of Items | Pages of Appendix | Number of Figures | Number of Tables | Number of Questions | Number of Problems | Number of Sample Problems |
|---|---|---|---|---|---|---|---|
| A | 105 | 3 | 542 | 28 | 451 | 137 | 160 |
| B | 78 | 6 | 468 | 7 | - | 870 | 42 |
| C | 96 | - | 437 | 16 | 501 | 347 | 38 |
| D | 70 | - | 548 | 28 | - | - | 185 |
| E | 39 | 9 | 157 | - | 597 | - | - |
| F | 95 | 14.5 | 666 | 20 | 627 | 551 | 141 |
| G | 47 | 3 | 262 | 7 | - | 600 | 51 |
| H | 77 | 3.5 | 218 | 7 | 117 | 139 | 78 |
| I | 42 | - | 253 | 3 | - | - | 23 |
| J | 49 | - | 203 | 3 | - | - | - |
| K | 68 | - | 113 | 2 | 6 | - | 5 |
| L | 47 | 5.5 | 145 | 2 | - | - | - |
| M | 72 | - | 207 | 10 | 219 | 129 | 51 |
| N | 49 | 10.5 | 130 | 4 | 180 | 54 | 13 |
| O | 60 | - | 233 | 5 | - | 37 | 15 |
| Mean | 65.17 | 3.8 | 304.5 | 9.4 | 169.5 | 216.5 | 56 |

Table 3. (Concluded)

| Book | Number of Formulas | Number of Pages | Number of Symbols | Pages of Summary | Pages of Index | Pages of Content | Number of Chapters | Title of Author |
|---|---|---|---|---|---|---|---|---|
| A | 165 | 694 | - | - | 11 | 5.5 | 34 | Prof.Phy. |
| B | 55 | 569 | 14 | 15 | 10 | 5.5 | 16 | Prof.E.E. |
| C | 72 | 597 | - | 29 | 11.5 | 1 | 23 | Prof.Phy. |
| D | 90 | 646 | - | - | 13.5 | 4 | 53 | E.E. |
| E | - | 226 | - | 4 | 4 | 8 | 18 | Tchr.Sci. |
| F | 173 | 850* | - | - | 14 | 16 | 27 | Prof.E.E. |
| G | 20 | 306 | 15 | 13 | 7 | 3 | 10 | Prof.E.E. |
| H | 123 | 278 | 8 | - | 5.5 | 2.5 | 10 | Prof.Phy. |
| I | 5 | 248 | 7 | - | 3.5 | 1 | 10 | Many Au. |
| J | 1 | 209 | - | - | 2.75 | 2 | 16 | Au.-E.E. |
| K | 5 | 333 | 25 | - | 3 | 10.5 | 12 | Tchr.Sci. |
| L | 5 | 185 | - | - | 6 | 0.5 | 12 | Au.-E.E. |
| M | 20 | 235 | - | - | 2.5 | 3 | 12 | Tchr.Phy. |
| N | 14 | 258 | - | - | 4 | 0.75 | 12 | Prof.Phy. |
| O | 5 | 297 | 9 | - | 6.5 | 0.75 | 19 | Prof.Sci. |
| Mean | 57.5 | 377.4 | 5.8 | 4.0 | 7.3 | 4.0 | 17.2 | |

*2 Volumes

## DISCUSSION OF FINDINGS AS INDICATED IN TABLE 3

This table is important for several reasons, as indicated in the discussion that follows.

It gives the reader an approximate idea of the attention devoted to the mechanics of the average textbook and an insight into many important things in a text that do not show up in an analysis of subject matter. It also helps in determining to what extent problems, questions, summaries, etc. are being used to aid in teaching electricity.

Pages devoted to an index are important facts in a book, as is also the number of sample problems. A great many problems in a book without answers are of little value except to a teacher, and the same applies to questions. They are merely testing materials.

The wide diversity of opinions is as evident in this table as it was in the other two.

Particular attention should be paid to the use of space for figures. The reader will note the mean is 304.5 and the range 130 to 636. These figures may be divided into five classes: schematic drawings, curves, graphs, freehand drawings, and plain photographs of experimental apparatus, electrical machinery, and other electrical devices, as well as parts of these. Many of these depict obsolete equipment, and many others show nothing but external views. They vary from a picture of a frog's leg to one of Niagara Falls. The presence of many of these is due to the fact that the plates are furnished free by companies for advertising purposes.

Table 3 should be used in conjunction with Tables 1 and 2 when analyzing and evaluating a book.

## SUMMARY

The writer's aim in this thesis has been to analyze and evaluate all elementary textbooks suitable for a study of elementary electricity [1] and then to use these findings in order to set up a preliminary standard that will be of value in the selection of a suitable book on this subject.

Every student of electricity is aware of the fact that there is a lack

1/ See Appendix A, p.67.

of uniformity of opinion among authors of elementary textbooks, not only as to what subject matter should be included, but also as to what methods are best adapted for its presentation. Unless these students have made systematic studies, similar to this one, however, it is impossible for them to realize fully the extent of this disorganization.

The chief reasons for these conditions are that many authors are physics or science teachers, and as such they think of electricity from an historical or experimental point of view. Consequently the writing of a book results in more or less a repetition of material, without any attention to the social, economic, and industrial conditions governing the electrical industry. Textbook writers still think of electricity as a sub-division of the sciences, instead of as an important independent subject.

In Table 3, under the heading of "Title of Author" we find that the authors of fifteen elementary electricity texts may be classified as follows: professors or teachers of physics, five; professors or teachers of science, three; professors of electrical engineering, two; electrical engineers who are authors or inventors, two; practical electrical engineers, one; authors in collaboration, one.

When the above data are studied it is evident that in the selection of a text particular attention should be paid to the training, experience, and background of the author for the following reasons: (1) the electrical engineer is most liable to be too technical; (2) the author or lecturer caters to the interest of his readers; and (3) the practical man is sure to emphasize whatever his specialty is or has been.

The first step was to classify the subject matter of each book under

items as shown in Table 1. The order in which these items occurred in each book and the space devoted to them was noted and tabulated.

Each book was then checked to find chapters, problems, questions, summaries, etc. The mean of each of these was found and the results tabulated.1/

Data recorded on these two tables formed a basis for the average against which anyone could check and evaluate an electricity book or course of study, provided he was satisfied to accept the opinions of the majority of the authors of such books.

In addition to this, however, it was realized that much valuable information is to be obtained from the writings of many learned men who are experts in their professions, and that in an analysis of this kind nothing must be overlooked.

With this in mind the writer selected at random from the tabulations a few items which, in his opinion, were over-emphasized, under-emphasized, or obsolete, and he obtained as much information as possible from all available sources to substantiate his contentions. In addition to the reading of more advanced texts, periodicals were studied, executives of companies were interviewed, pamphlets on items involved were procured from manufacturers, and at the same time professors, teachers of electricity, contractors, and electricians in the trade were consulted. The writer used the data obtained to test samples of the tabulated items, and he found that they did not correspond with the conclusions shown by the analysis of the texts. The attention of the reader is called to this discrepancy in order to impress on him the importance of checking each doubtful item for him-

1/ See Table 3, p.61-62.

self, and the folly of accepting the analysis of authors' statements without due thought.

**********

This is only a preliminary study, and unless it stimulates research that will eventually create a valid standard, the objectives of the writer will not have been accomplished.

Much valuable information may be obtained when checking a book in the manner suggested in this study, even if Tables 1 and 3 alone are accepted as a standard, provided the reader will study carefully the range and mean of pages of each item, its relative position as given by each author, and the number of authors discussing it. This study should also be helpful as a guide when constructing or reconstructing a course of study.

It is the writer's sincere hope that this thesis may inspire some author in the field of electricity to write a text based on scientific analysis, careful research, and present demands which will meet the needs of the teacher and those interested in the study of electricity.

# APPENDIX A

## TEXTS ANALYZED IN THIS STUDY

Book M - Burns, Elmer E., A Study of First Principles of Electricity, D. Van Nostrand Company, New York, 1930, ix; 235 p.

Book L - Collins, A. Fredrick, Book of Electricity, D. Appleton-Century Company, New York, 1937, xiv; 185 p.

Book D - Croft, Terrell, Practical Electricity (Second Edition), McGraw-Hill Book Company, New York, 1920, viii; 646 p.

Book F - Dawes, Chester L., Industrial Electricity, Vols. I and II, McGraw-Hill Book Company, New York, 1925, xiv,371; xv, 480 p.

Book A - Hausmann, Erick, Swoops Lessons in Practical Electricity, (Seventeenth Edition), D. Van Nostrand Company, New York, 1927, xiii; 694 p.

Book C - Jackson and Black, Elementary Electricity and Magnetism, (Revised Edition), The Macmillan Company, New York, 1926, vii; 598 p.

Book N - Jones, E.W., Essentials of Applied Electricity (Revised Edition), Bruce Publishing Company, Milwaukee, 1935, 258 p.

Book O - Lunt, Joseph R., Everyday Electricity, The Macmillan Company, New York, 1937, x; 297 p.

Book E - Meister, Morris, Magnetism and Electricity, Charles Scribner's Sons, New York, 1935, v;226 p.

Book I - Millikan-Bishop, Elements of Electricity, American Technical Society, Chicago, Illinois, 1937, 248 p.

Book J - Morgan, Alfred, A First Electricity Book for Boys, Charles Scribner's Sons, New York, 1936, xii;209 p.

Book H - Slack, Edgar P., Elementary Electricity, McGraw-Hill Book Company, New York, 1937, ix;271 p.

Book K - Small, Sidney A., Boys' Book of Electricity, H.P.Dutton Company, New York, 1931, 333 p.

Book B - Timbie, William H., Elements of Electricity (Third Edition), John Wiley and Sons, New York, 1937, x;569 p.

Book G - Timbie, William H., Essentials of Electricity (Second Edition), John Wiley and Sons, New York, 1935, xi;306 p.

# APPENDIX B

## SOURCES OF VALUABLE INFORMATION USED IN THIS STUDY

1. Aerovox Research Worker, Aerovox Company, Brooklyn, N.Y.
2. American Institute of Electrical Engineers, New York City.
3. American Year Book, American Year Book Company, New York City.
4. Association of American Railroads, Engineering Division, New York City.
5. Babson Reports, College Section Division, Wellesley Hills, Mass.
6. Bell Laboratory Records, Bell Telephone Company, New York City.
7. Book Review Digest (1937-1938), H.W.Wilson Company, New York City.
8. Cumulative Book Index, H.W.Wilson Company, New York City.
9. United States Catalogue, H.W.Wilson Company, New York City.
10. Edison Electric Institute, New York City.
11. Educational Index, H.W.Wilson Company, New York City.
12. Edison Storage Battery Company, Orange, N.J.
13. Electric Merchandizing, McGraw-Hill Book Company, New York City.
14. Federal Power Commission, Washington, D.C.
15. General Electric Sales Promotion Division, Schenectady, N.Y.
16. Industrial Arts Index, H.W.Wilson Company, New York City.
17. List of Inspected Electrical Appliances for 1937, Underwriter's Laboratories, Chicago, Illinois.
18. List of Publications of the National Educational Association of the United States (October 10, 1937).

19. Periodical Directory, by Carolyn F. Ulrich, R.R.Bowker Company, New York City.

20. Reader's Guide to Periodical Literature, H.W.Wilson Company, New York City.

21. Standard Catalogue for High School Librarians, with Supplement, H.W. Wilson Company, New York City.

22. Superintendent of Documents, Washington, D.C.

23. Supplement to the 1937 List of Electrical Apparatus, Underwriter's Laboratories, Chicago, Illinois.

24. Technical Book Review Index, Special Library Association, New York City.

25. Supervision of Extension Courses, Industrial Relations Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

26. World Almanac and Book Facts, New York World, New York City.

# APPENDIX C

## PERSONAL LETTERS

COPY

ASSOCIATION OF AMERICAN RAILROADS
Operations and Maintenance Department
Electrical Section
59 East Van Buren Street
Chicago

Officers of Section

J.M.Symes, Vice-President.
Operations and Maintenance Department

H.F.Brown, Chairman
D.B.Thompson, Vice-Chairman
Walter S. Lacher, Secretary

New Haven,Conn.
April 5, 1938

Mr. John Y. Murray,
Rindge Technical School,
Cambridge, Mass.

Dear Mr. Murray:

Your letter of March 28th to the American Railroad Association has been referred to me.

.....

.....

.....

.....

..... There has been no major installation of third-rail since 1910, the trend being entirely toward an overhead contact system, and from the relative mileage you will note that, in spite of the three or four installations of 3000 volt direct current, the major trend seems to be in favor of the 11000 volt, single phase, alternating current, this having been adopted by the Pennsylvania Railroad for their entire electrification program. So much for the trend in this country. Abroad on the continent the trend in Sweden, Germany, Austria and Switzerland all seems to be in favor of the single phase, alternating current, high voltage system, whereas in England, Franceand to a limited extent in Italy the major electrifications are about

1500 volt, direct current, the ruling factor being somewhat the type of power supply available. If you wish to follow up this subject further in detail, there is a very extensive bibliography on railway electrification on file in the American Transsit Association headquarters at 292 Madison Ave., New York, and there have also been numerous reports by the American Railway Association, the National Electric Light Association (now the Edison Electric Institute), and the report of the Chicago Smoke Commission in 1916 also deals extensively with this subject.

Referring to your second question as to what types of batteries are used in connection with rail bonds, I assume that you have in mind power supply track circuits for signaling. The modern trend in this connection seems to be toward a relatively low capacity power supply line (usually A.C.) from which are charged, by means of rectifiers, low voltage storage batteries which are "floating" on the line. Where power supply lines are not available, primary batteries are used and usually these are the so-called "gravity" type. To the best of my knowledge, dry batteries are very seldom used.

.....

Trusting this gives you the information you desire, I am

Yours very truly,

(Signed) H.F.BROWN

Chairman

(Asst.Elec.Engr.,N.Y.N.H.& H.R.R.)

COPY

PHILADELPHIA ELECTRIC COMPANY
1000 Chestnut Street
Philadelphia

H.B.Bryans
Vice-President

March 29, 1938

Mr. John Y. Murray
Rindge Technical School
Cambridge, Mass.

Dear Mr. Murray:

In reply to your letter of March 28, the supply of direct current in Philadelphia was discontinued in October, 1935.

.....

If there is any other information you wish, please let me know.

Yours very truly,

(Signed) H.B.BRYANS

Vice President

COPY

BRYANT MANUFACTURING COMPANY

Manufacturers of Railway Signal Supplies
Battery Zincs, Coppers, etc.
Hard Vulcanized Fibre Tags & Specialties

New York Office
Rooms 1501-2-3 Times Bldg.
Tel. Bryant 3983-3984
Long Distance 603

Factory: 456-466 W.Ontario Street
Telephone Superior 4628
Chicago

New Addresses
N.Y.Office: 246 - 5th Ave.
Chicago Off: 401 N. Paulina St.
Seeley 5482

Mr. John Y. Murray,
Rindge Technical School,
Cambridge, Mass.

March 24, 1938.

Dear Sir:

We have yours of the 22th inst. asking for a list of wet batteries and their chief use of each.

.....

.....

The #3 Crowfoot Battery Zinc or 6 X 8 cell is the one most used by the telephone and telegraph companies. Can use #1-2-3-4-6-7-8 zinc with this battery. The #8 zinc is used mostly by railroads for signal work and fire alarm companies for fire alarm work. The railroads have changed over to the caustic soda (Edison) type battery in the last years, on account of less maintenance work, as the wet cell, gravity type has to have the right density in order to work properly, and needs more attention.

The #5- 5 X 7 Zinc can also be used for telephone and telegraph work but is not in such demand as the larger type.

The Cylinder type #14 and #15 zincs is used for door bell ringing, also the Pencil Zinc type #11-12-13-30-24-25-26 but is obsolete. This is the battery composed of Carbon, zinc, Sal Ammoniac and water.

The Telegraph companies are gradually getting away from the wet cell and are using a transformer to reduce or change their current to fit their instruments, in conjunction with a radio tube.

Trust this information will be of some value to you and should you desire more information will be glad to give same.

Yours very truly,

Bryant Manufacturing Co.

(Signed) H.BURKLAND

Manager.

HB-NS

Catalogue under separate cover.

COPY

EDISON ELECTRIC INSTITUTE
420 Lexington Avenue, New York

April 2nd 1938

Mr. John Y. Murray
Rindge Technical School
Cambridge, Mass.

Dear Sir:

In reply to yours of March 30, I am sending a copy of our last statistical bulletin which gives you an idea of the trend of the business.

.....

The importance of direct current in the public utility field is steadily growing less and, outside of certain chemical plants and in transportation, its use is restricted to the older sections of a few cities such as Boston and New York. About 3% of the energy in this country is generated as D C and perhaps 10% of the energy used is D C. The largest consumers are the trolley and subway lines which last year used some 6 billion kwhrs, with electrochemistry--notably the production of aluminum--taking perhaps 4 billion more.

The 3 phase-4 wire systems are becoming increasingly popular and there is a strong tendency not only to install them on new work but to change over the older 3 phase-3 wire delta systems to it. I cannot give you any definite figures and future work depends very largely on the revival of building construction and repair in this country.

.....

Yours very truly

(Signed) Wm. M. Carpenter

Wm. M. Carpenter
Economist

COPY

THE HOLTZER-CABOT ELECTRIC CO.

Executive Offices and Factory, 125 Amory St.,Boston,Mass.

BOSTON

Cable-Holtzer-Boston
A B C 6th Edition Code Used

In Reply Refer to AAC:AEM:#33
April 7th, 1938.

Mr. John Y. Murray,
Rindge Tech School,
Electrical Department,
Cambridge, Massachusetts.

Dear Sir:

I have your letter of March 31st requesting information on the operation of Intercommunicating Telephone System as used in apartments and houses. I will, as far as I am able, answer your questions in the order in which you have listed them in your letter.

A. It is standard practice now to operate Intercommunicating Telephone Systems from rectifiers.

B. Type of rectifier most commonly used is the copper oxide type.

C. Following is an approximate proportion of the different types of sources of energy used for Intercommunicating Telephone Systems

| | |
|---|---|
| Rectifier | 15% |
| Dry Cells | 20% |
| Storage Battery | 60% |
| Primary Battery | 5% |

D. In metropolitan district of Boston where direct current only is available, most of the systems are operated on dry cells and a few are operated on storage batteries charged by means of motor generator sets.

I trust that the above information is what you require, and if there is any further information we can give you, kindly let us know.

Yours very truly
THE HOLTZER-CABOR ELECTRIC CO.
(Signed) A.A.CHURCH
N.E.Signal Sales Division

COPY

HARVARD UNIVERSITY

GRADUATE SCHOOL OF ENGINEERING

Chester L. Dawes
Associate Professor of Electrical Engineering

Pierce Hall
Cambridge, Massachusetts

April 20, 1938

Mr. John Murray
Rindge Technical School
Cambridge, Mass.

Dear Mr. Murray:

I was delayed in answering your letter of April 13 since I was in New York the latter part of this last week. I have given considerable thought to your question as to the proportion of direct currents and alternating currents theory which should be given in an elementary course to students in High School. It is difficult to give exact proportions but fifty per cent of each will not be far out of the way. I would be inclined to favor fifty-five or sixty per cent direct current provided such subjects as capacitance, inductance and induced e.m.f. are given in the direct current work.

With solid training in these subjects as background, I have found that students pick up the alternating current theory quite rapidly. For example, with the generation of a direct current e.m.f. it is necessary to show the students that in a direct current generator coil an alternating current is generated and commutation must be used to obtain direct current. Thus the student assimilates the idea of alternating current sine wave, frequencies, etc. Also in a study of capacitance and inductance he learns that a current can flow into charge a condenser without passing through the dielectric and that inductance tends to prevent changing current.

If the student understands these factors well, together with similar ones, he should pick up alternating current rapidly.

It would be easier for me to give a more definite answer if I knew specifically the subjects which you take up and the order in which they are given. If a personal conference would be of any further assistance to you, I would be only too glad to sit down and talk the matter over with you.

Very truly yours,

CLD:M

(Signed) Chester L. Dawes

COPY

WILLARD STORAGE BATTERY COMPANY

Main Office and Factory
246-286 E.131st St.
Cleveland, Ohio

Address your
Reply to

April 6, 1938.

Mr. John Y. Murray,
Rindge Technical School,
Cambridge, Mass.

Dear Sir:-

In response to your request of April 4th for some information on the Willard Low Discharge line of batteries I am forwarding to you, under separate cover, our Low Discharge battery folder which fully describes these batteries and illustrates several applications.

This is a comparatively new line and is being used quite extensively by the U.S.Government in marine service. Many installations are in use on highway flashers, train signals, fire alarms, etc.

.....

Very truly yours

WILLARD STORAGE BATTERY COMPANY

(Signed) H.E.EVANS
H.E.Evans

Sales Promotion Manager

HEE/AHP

COPY

THE WESTERN UNION TELEGRAPH COMPANY
230 Congress Street
Boston, Mass.

J.H.Groves
Superintendent

April 1, 1938.

Mr. John Y. Murray,
Care Rindge Technical School,
Cambridge, Mass.

Dear Sir:

We have your letter of March 29, and are pleased to furnish you the following information:

We use motor generators. The motors are 3 phase A.C.-208 volts with standard motor generator benches and panels. They are used for 24 hour period. Our power supply is furnished by the Edison Electric Illuminating Company. Keys, sounders and relays are used on regulating sets in our test-room; also on a few Morse operated circuits. The majority of our business is now handled over multiplex and teleprinter machines and a small portion by Morse.

Any time it is convenient for you to call at our Main Office, I shall be pleased to have someone explain all of these details and show you the actual operation.

Very truly yours,

(Signed) J.H.GROVES

Superintendent

COPY

THE WESTERN UNION TELEGRAPH COMPANY
230 Congress Street
Boston, Mass.

J.H.Groves
Superintendent

April 13, 1938.

Mr. John Y. Murray,
Rindge Technical School,
Cambridge, Mass.

Dear Sir:

I am glad to furnish the following information in answer to the queries raised in your letter of April 5,

In rural sections and in railroad offices we ordinarily use main line sounders which do not require local current. Where that is not possible because of the length of the circuit, or for any other reason, we use rectifiers, storage batteries or motor generators.

Although a good many railroads still use the Morse method of handling train dispatching and telegrams, some have adopted the use of telephone circuits as a substitute. In this part of the country the New York, New Haven and Hartford Railroad uses telephone circuits, the Boston & Maine and Boston and Albany use both Morse and telephone, the Maine Central and Bangor and Aroostook use Morse entirely.

Yours truly,

(Signed) J.H.GROVES

Superintendent

COPY

NEW ENGLAND POWER ASSOCIATION
441 Stuart Street
Boston, Massachusetts

April 11, 1938

Mr. John Y. Murray
Rindge Technical High School
Cambridge, Massachusetts

Dear Sir:

The name "New England Power Association" means the trustees for the time being (as trustees but not individually) under an agreement and declaration of trust dated January 2, 1926, as amended, which is hereby referred to, and a copy of which as amended has been filed with the Commissioner of Corporations and Taxation of the Commonwealth of Massachusetts. Any agreement, obligation or liability made, entered into or incurred by or in behalf of said association binds only the trust estate, and no shareholder, director, trustee, officer or agent thereof assumes or shall be held to any liability therefor.

Pursuant to your recent request we submit the following information:

Total kwh sold for the year ended December 31, 1937 by Subsidiaries of NEW ENGLAND POWER ASSOCIATION Consolidated was 1,971,331,997

It is estimated that of this amount 6,686,000 kwh was sold by Direct Current, which is approximately 0.3% of the total kwh sold.

All information herein is furnished solely for your statistical records. It is not and should not be taken to be a prospectus, notice, circular, advertisement, letter, communication or representation of any kind issued with reference to the sale of, offer of sale of, or solicitation of an offer to buy or sell any security or interest in any security now or hereafter issued.

Very truly yours

NEW ENGLAND POWER ASSOCIATION
(Signed) H.HANSON
TREASURER

COPY

THE COMMONWEALTH OF MASSACHUSETTS
Department of Education
State House, Boston

April 6, 1938

Division of
Elementary & Secondary
Education & State Teachers
Colleges

Mr. John Y. Murray
Rindge Technical School
Cambridge, Massachusetts

My dear Mr. Murray:

The State Department of Education has no course of study in electricity for high schools for distribution.

.....

Very truly yours,

(Signed) A. RUSSELL MACK

Supervisor of Secondary Education

T/1

COPY

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF EDUCATION
WASHINGTON

April 8, 1938.

Mr. John Y. Murray
Rindge Technical School
Cambridge, Mass.

Dear Sir:

You ask in your letter of recent date to suggest text books on electricity suitable for secondary school use. It is difficult to recommend text books particularly since there are so many good books in science which have sections devoted to electricity. Too, the field of electricity is so broad that any text book emphasizing a particular phase of electricity such as motors or dynamos would be apt to leave out considerable basic material necessary for well grounded training in this field.

.....

Very truly yours,

(Signed) G. A. Mc GARVEY

G.A.McGarvey
Agent
Industrial Education

COPY

STATE OF WISCONSIN
DEPARTMENT OF PUBLIC INSTRUCTION
MADISON

John Callahan
State Superintendent

April 13, 1938

J. F. Waddell
Asst.State Superintendent

Mr. John Y. Murray
Rindge Technical School
Cambridge, Massachusetts

Dear Sir:

Your letter of April 6 has been referred to me for reply.

We do not have a uniform course in industrial arts for our state. The qualifications of a teacher of electrical work is quite generally three or four years of preparation, preferably four or more, in Wisconsin high schools and grades.

Yours very truly,

(Signed) A.R.PAGE

Supervisor of Secondary Schools

ARP:GEC

COPY

NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY
750 Massachusetts Avenue
Cambridge A, Mass.

F.A.Shurtleff
Manager

Telephone
TROwbridge 9950

April 4, 1938

Mr. John Y. Murray, Instructor
Rindge Technical School
Cambridge, Mass.

Dear Mr. Murray:

Arrangements have been made, in accordance with your letter of March 31, to provide you with the information which you requested relative to the use of our storage batteries.

In the meantime, I would like to extend to you an invitation to visit our Central Office at 10 Ware Street, Cambridge where our Wire Chief, Mr. Kelley, will be glad to have the equipment used there explained to you in detail.

Yours very truly,

(Signed) F.A.SHURTLEFF

Manager

FAS:D

COPY

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Peter T. Schoemann, Milwaukee
Emil Waldow, Green Bay
John Wikstrand, Superior

Ex-Officio Members

John Callahan, State Superintendent of Schools, Madison
Voyta Wrabetz, State Industrial Commissioner, Madison

Farmer Members

Paul Weis, Barnum
J.E.Leverich, Sparta
Edward R. Roll, Eau Claire

Employer Members

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Jessel S. Whyte, Kenosha

WISCONSIN
STATE BOARD OF VOCATIONAL EDUCATION

Geo. P. Hambrecht, Director
1 West Wilson Street
Madison, Wisconsin

April 4, 1938

President E.W.Schultz, Sheboygan
Vice-President Peter T. Schoemann, Milwaukee
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H.C.Thayer, Teacher Training
Jennie M. Turner, Asst.Teacher Training
E.E.Gunn, Jr., Assistant Director

Mr. John Y. Murray
Rindge Technical School
Cambridge, Massachusetts

Dear Mr. Murray:

In Wisconsin the State Board of Vocational and Adult Education has no connection with the industrial arts or practical arts work carried on in the

high schools; that comes under the Department of Public Instruction. We do however have in the forty-four local schools of vocational and adult education throughout the state a number of departments of electricity. In addition there are two circuit teachers in this field who travel among a number of schools either supplying or supplementing the instruction in electricity.

We do not have any such thing as a uniform state course in electricity; the particular needs of the local groups in this field govern what is offered. All of the men handling this work are thoroughly competent from the trade standpoint with ample backgrounds of trade experience. Then they go forward with teacher training programs worked out individually; in service teacher training both on the job during the school year and in summer schools. Under separate cover you will find some bulletin material which you may find of interest. There is also a current directory of the personnel in the local schools. Mr. Anderson and Mr. Patterson, the circuit teachers in electricity, might have some material developed which you could use; I would suggest that you write them direct. Then by looking through the body of the directory you can see who is handling instruction in electricity in the various local schools.

Very truly yours,

(Signed) H.C.THAYER

Teacher Training Supervisor
Trade and Industrial Education

H.C.Thayer
MM
CC: Hambrecht, Gunn

COPY

WETMORE-SAVAGE DIVISION

Boston, Mass.
Springfield, Mass.
Worcester, Mass.
Providence, R.I.
Burlington, Vt.
Bangor, Maine
Augusta, Maine

WESTINGHOUSE
ELECTRIC
SUPPLY CO.

76 Pearl Street, Boston

April 2, 1938

Subject

In Reply Refer to
EVW/aem

Mr. John Y. Murray
Rindge Tech. School
Cambridge, Mass.

Dear Mr. Murray:

We have your note of the 31st regarding doorbells and batteries. The so-called wet cell has practically gone out of existence. A few of the telephone companies still use the old close-circuit type of cell using the copper and lead - but the regular wet cell is practically out of existence.

We still sell a few of the old zincs for batteries that are probably still in use; but practical everybody now-a-days in the AC territory, of course, use a bell ringing transformer and in the DC areas use ordinary dry cells.

Glad to hear from you once more.

Yours very truly

Wetmore-Savage Division
Westinghouse E. S. Co.

(Signed) E. VAL WETMORE
m

COPY

ELECTRICAL WORLD

McGraw-Hill Building
330 West 42nd Street
New York, N.Y.

April 12, 1938.

Mr. John Y. Murray
Rindge Technical School,
Cambridge, Mass.

Dear Sir:

The following are the best answers we can give to your inquiry of April 5:

.....
.....
.....
.....
.....

There is no conflict between the study of d.c. and a.c. The former, being simpler, is advisable as an introduction to a.c., irrespective of the amount of use of either type of current in present-day practice.

Yours very truly,

(Signed) G.F.WITTIG

G.F.Wittig,
Statistical Editor.

EW-sjm

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